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| AECD-2053 1-16 | Late effects of radium and plutonium on bone. Margaret A. Bloom and William Bloom. | Arch. Path. 47, 494-511 (1949) May. |
| AECD-2154 1-851 | The quantitative spectrographic analysis of the rare earth elements. III. Determination of major constituents in complex mixtures. Velmer A. Fassel. | J. Optical Soc. Am. 39, 187-193 (1949) Feb. |
| AECD-2349 1-1743 | A preliminary investigation of the spectra of uranium isotopes. J. Rand McNally, Jr. | J. Optical Soc. Am. 39, 271-277 (1949) Apr. |
| AECD-2451 2-988 | Electron-neutrino correlation in heavy elements. M. E. Rose. | Phys. Rev. 75, 1444 (1949) May 1. |
| AECD-2484 2-1383 | Neutron and proton binding energies in the region of lead. Katharine Way. | Phys. Rev. 75, 1448-1449 (1949) May 1. |
| AECD-2533 2-1596 | Inelastic scattering of 14.5-Mev neutrons by lead. H. T. Gittings, H. H. Barschall, and G. G. Everhart. | Phys. Rev. 75, 1610-1611 (1949) May 15. |
| AECD-2547 2-1667 | Decay of 8-day $I^{131}$ to a metastable state of $Xe^{131}$. A. R. Brosi, T. W. DeWitt, and H. Zeldes. | Phys. Rev. 75, 1615-1616 (1949) May 15. |
| AECU-84 2-1024 | The metabolism of radioactive pentabarbitol in mice. Lloyd J. Roth, Edgar Leifer, John R. Hogness, and Wright H. Langham. | J. Biol. Chem. 178, 963-965 (1949) Apr. |
| AECU-169 2-1799 | Charged particles emitted by carbon bombarded by 90-Mev neutrons. Keith Brueckner and Wilson M. Powell. | Phys. Rev. 75, 1274-1275 (1949) Apr. 15. |
| AECU-196. 2-1954 | Some possible rare stable isotopes. Henry E. Duckworth. | Phys. Rev. 75, 1438 (1949) May 1. |
| AECU-202 2-2123 | Search for stable $Pd^{100}$, $W^{178}$ and, $Pb^{202}$. Henry E. Duckworth, Robert F. Black, and Richard F. Woodcock. | Phys. Rev. 75, 1616-1617 (1949) May 15. |
| AECU-220 3-135 | A new stable isotope of platinum. Henry E. Duckworth, Robert F. Black, and Richard F. Woodcock. | Phys. Rev. 75, 1438-1439 (1949) May 1. |

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## GENERAL

192 On the possible amount of radioactive poisoning by fission products of $U^{235}$. Hans Thirring. Acta Phys. Aust. 2, 379-400(1949)(in German).

An estimation is made of the lethal properties of the radioactive fission products of $U^{235}$ which could be used as a military weapon in the form of a thin coat adhering to sand after it has been moistened with radioactive salts and dried. Among the fission products the $\gamma$- and $\beta$-emitters, $Sr^{89}$, $Y^{91}$, $Zr^{95}$, $Cb^{95}$, $Ru^{103}$, $I^{131}$, $Ba^{140}$, $La^{140}$, $Ce^{141}$, $Pr^{144}$, $Pr^{143}$, $Nd^{147}$ are singled out because of their energies, half-life periods, and yields. It is found that an isotope mixture weighing 0.03 mg has an activity of 1 curie and that 6 tons of sand, brought by plane or rocket bomb, would carry 1 milliard curies. The doses would greatly exceed the lethal doses of $\gamma$-rays recognized by authorities ($65 \times 10^6$ gram-roentgen, according to Innes, Brit. Med. Bull. 4, 51(1946)). Assuming that, by 1960, the total public utility and industrial energy production in the United States will reach $60 \times 10^6$ kw, and that 20% of this amount will be obtained from uranium piles, it is shown that this country would be able, at the outbreak of a war, and depending on the degree of devastation contemplated, to cover an area of from 9,000 to 140,000 $km^2$, and from 4,500 to 70,000 $km^2$ each succeeding month.

193 Atom powered bombers. W. Winter. Air Trials 32, 21-23, 85-9(1949) May.

The theoretical possibilities of using nuclear energy as a source of power for bombers and rockets are explored. It is suggested that plutonium or $U^{235}$ would be probable fuels for the nuclear engine. The basic details of the various types of power plants which might be adapted for use with a nuclear reactor are discussed. Since the energy of fission is released mainly as heat, these are all thermal power plants, such as the steam or mercury turbine, the turbojet, the ramjet, and the rocket. In the case of the turbojet, the nuclear reactor simply replaces the familiar combustion chamber. It is noted that a 25,000 horsepower engine would require 75 tons of lead shielding and some of the problems which would result from constructing aircraft several times as large as a B-36 are discussed.

194 Fission particles as rocket propellants. Part I. Wayne Proell. Space Flight 1, 1-7(1949) June.

The possibility of using fission particles as rocket propellants, previously suggested by Bowman (Rocket News Letter 2, 9(1949) May) is considered. Such particles constitute a self-accelerated type of particle which can properly be considered as a means of getting a high-energy low-mass rocket jet. A theoretical discussion of the basic energy considerations is given and the mechanism of thrust production is treated. Calculations of the amount of thrust per fission are made and it is estimated that $9.10 \times 10^{19}$ (or 0.0353 g) uranium atoms must fission to supply the necessary thrust for obtaining a rocket velocity of 1 cm/sec. (These calculations are based on a geometric efficiency of 50%). Tabulated calculations relating the particle velocity to the required weight of fissioning uranium and relating the fission rate to the thrust are given.

195 Nuclear power for mobile use. Andrew W. Kramer Power Generation 53, 78-80(1949) Feb.

The principles of design which would have to be applied in the construction of a nuclear power plant for mobile use (aircraft and submarines) are discussed. Diagrams of possible simple constructions for such power plants are shown and the shielding problem is discussed in some detail. It is noted that owing to military interest in mobile applications of the nuclear reactor as a source of power, it is not unlikely that the more difficult problems encountered in such applications will be solved to produce mobile nuclear power plants before stationary power plants of this type are in operation.

## BIOLOGY & MEDICINE

196 The effect of lethal doses of x-rays on chilled and thyroidectomized animals. Louis H. Hempelmann, Teodore T. Trujillo, and Norman P. Knowlton, Jr. AECU-239, nd. 15p.

New born rats chilled to 2-5°C before exposure to lethal amounts of x-ray irradiation showed an increased survival rate as compared to unchilled control rats. The lowering of the environmental temperature of adult mice exposed to 675 of x-ray decreased the thirty-day survival rate. Adult rats

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and mice showed no significant increase in the thirty-day survival rate when chilled after, or before and after irradiation. Adult rats were not protected from the lethal effects of x-radiation by thyroidectomy.

197 The effect of x-rays on immunity. William H. Taliaferro and Lucy Graves Taliaferro. AECU-240, June, 1946. 42p.

The present review is concerned with x-irradiation in connection with the following subjects: (1) the formation of specific antibodies after immunization with nonliving antigens; (2) infection with animal parasites, (3) infection with bacteria and viruses, and (4) mechanisms of radiation effects in the host. In dealing with these subjects, the therapeutic use of irradiation in man is mentioned cursorily. The review brings together a bibliography and cites briefly the types of results that have been obtained. The size of x-radiation dosages has been given when possible, together with whether exposure was local or overall, and in some cases, the resulting biological effects such as atrophy of the lymphoid tissue and leucopenia. This procedure suffices to indicate roughly whether small or large dosages were used. 158 references.

198 Relation of gamma-ray dosage rate to mitotic effect in the grasshopper neuroblast. J. Gordon Carlson, Mary Louise Snyder, and Alexander Hollaender. AECU-243, May 31, 1949. 13p. (See also MDDC-1576.)

Eggs of the grasshopper, Chortophaga viridifasciata (DeGeer), containing 14-day embryos (at 26°C) were exposed to known doses of gamma rays given at certain selected dosage rates and then made into hanging-drop culture preparations. Treatment was at room temperature, (about 22°C). Treated and control embryos were prepared from the same pod of eggs. They were studied at 38 ± 0.3°C in an incubator enclosing the lower portion of a microscope. A gamma-ray dose of 8, 32, or 64 r produced the same degree of mitotic inhibition, whether administered at a rate of 2 r per minute or 32 r per minute. A gamma-ray dose of 128 or 256 r was more effective in depressing mitosis if given at 32 r per minute than at 2 r per minute. This document is a revision and amplification of MDDC-1576.

199 The applications of plant growth regulators including radiations to research in pharmacognosy. H. W. Youngken, Jr. Am. J. Pharm. Education 13, 141-9(1949) Jan.

The effects on plant growth of some of the natural and synthetic phytohormones and other organic agents and such physical growth regulators as those caused by radiations and produced by uranium pile exposures, cyclotrons, radium, and x-rays are discussed. A survey of the work being done in the plant field with the physical growth regulators and radioactive tracers is presented. It is concluded that with the use of radioactive isotopes the pharmacognosist, through drug biosynthesis and labelling tracers, might well provide the physiologist and pharmacologist with additional tools for better understanding drug action in animals. 30 references.

200 Degenerative and regenerative changes in the thyroid gland following high dosages of radioactive iodine. Aubrey Gorbman. Trans. N. Y. Acad. Sci. 2, 201-3(1949) Apr.

The results of experimental studies to determine the degree of thyroidal and other tissue injury per given amount of radioiodine are given. Mice of C57-CFW- strain, whose thyroid glands had an average weight of 5 mg, were used. They were injected subcutaneously with 100, 200, 400, or 1,000 mc of $I^{131}$. The maximum uptake by the thyroid was 5-10% at 12-24 hr for the 100 and 200 mc doses. The "biological half-life" of the iodine was 2 days. By calculation, it was decided that the doses delivered were 26,000 and 75,000 equivalent r. The mice were sacrificed at intervals of 2, 3, 7, 24, 120, and 300 or more days after the injections. The severity of injury to the thyroid after two or three days varied from minimal to complete destruction within the 100-1000 mc range of dosages. Under specified circumstances, 200 μc. or more of $I^{131}$ cause complete thyroidal destruction in mice. Doses of 100 μc. permit survival of small bits of atypical thyroidal tissue, which even after 400 days show no tendency toward regeneration.

(The paper was presented at the meeting of the Section at Memorial Hospital, New York, N. Y., on March 14, 1949.)

BIOLOGY & MEDICINE (continued)

201 The effect of adrenocorticotrophic hormone and x-ray on the amount of circulating antibody. Edward E. Fischel, Marjorie LeMay, and Elvin A. Kabat. J. Immunol 61, 89-93(1949) Jan.

Experiments initiated to determine whether x-rays and the adrenocorticotrophic hormone are able to cause an anamnestic or secondary response in circulating rabbit antibodies are described. One group of rabbits received 25 mg of 75% potent ACTH subcutaneously, while the other group received 50 r, spray radiation with 184 kv and 25 ma, at a distance of 35.25 cm with 2 mm Cu and 1 mm Al filters. Bleeding times and white cell counts were obtained at 6, 12, and 48 hr after the administration of the ACTH and the x-rays. The results are presented in 2 tables. A fall of more than 50% in the total number of circulating lymphocytes occurred after the treatments for a corresponding change in the total white count either in the same or in the opposite direction. The serum antiovalbumin content was either the same or diminshed in all of the rabbits. Therefore, the expected anamnestic change was not demonstrable by the quantitative precipitin-method used. 17 references.

202 The effect of local roentgen irradiation on the biological behavior of a transplantable mouse carcinoma I. Increased Frequency of Pulmonary Metastasis. Henry S. Kaplan and Edwin D. Murphy. J. Natl. Cancer Inst. 9, 407-13(1949) Apr.-June.

In 5 series of experiments local roentgen radiations of 400-1,000 r, sublethal for the tumor, were administered to transplantable mammary tumor 755 growing subcutaneously in strain C57 black mice. Untreated mice selected at random from the same transfer generations were maintained as controls. Of 98 mice bearing irradiated tumors, 62 survived the determinate period of 6 1/2 to 8 weeks required for the development of microscopically demonstrable metastases. Fifty-two of 89 controls survived an equal period, and pulmonary metastases were found in 5, (9.6%). Since these differences are statistically highly significant, it is concluded that local irradiation under the conditions of these experiments produces an increased incidence of remote metastasis. Some of the possible mechanisms of this pnenomenon are suggested.

203 Effects of repeated low doses of neutrons on the estrous cycle of the white rat. James L. Leitch, Douglas M. Gay, and George A. Neville. Am. J. Roentgenol. Radium Therapy 61, 530-3(1949) Apr.

Further investigations of the effects of neutrons on white rats with particular reference to the relationships between tumor production and the possible appearance of an irregular estrous cycle are presented. Investigations of the effects of low neutron doses on the estrous cycle of the white rat as determined by vaginal smears are presented. A daily dose of 3 n was given to 23 rats 6 days a week until 111 n had been delivered. Hematological studies indicated a lowering of the white blood cell count to a minimum of 6,000-7,000 cu mm after 16 doses, followed by recovery. A slight loss of weight as well as a retardation of the growth occurred. The main effect was a disruption of the estrous cycle. Swellings appeared in the mammary glands, and are under investigation.

204 Histological and histochemical study of the skin of the guinea pig treated with x-rays. J. Frederic. Arch. biol. (Liége) 60, 79-101(1949)(in French).

A study was made of morphological changes produced by x-rays in the epidermis, and, in particular, in the histological elements containing substances with -SH groups (sulfhydriles). The skin of the paws of 32 guinea pigs was irradiated with 3000, 2000, and 1500 r. The histological and histochemical evolution is shown on 9 microphotographs.

205 Preliminary observations on the biological effects of radiation on the life cycle of trichinella spiralis. Joseph E. Alicata and George O. Burr. Science 109, 595-6(1949) June 10.

Six experiments to determine the effects of different periods of irradiation of the encysted trichinae larvae in meat are described. The method used in these experiments consisted in preparing small cellophane wrappings each enclosing about 1 g of trichinous rat meat and placing the packets between two tubes containing radioactive cobalt in a refrigerator at 4°C so as to deliver 2000 r to the meat over

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each 24 hr period. The rays emitted were largely γ-rays. After the meat was irradiated for a period of time, the contents of each of two wrappings was fed to two white rats. One of the animals was then killed and autopsied at 6 days and the other at 30 days after infection. The irradiation produced no lethal effect on the larvae and no change in their power to mature, but did produce an increased and variable effect on the reproductive cells of the adult female worms, and in the form of the body wall of the parasite. Irradiations for 4 days produced sterility in 12-36% of the female worms; for 5 days, sterility in 43-100%; and for 6 days, sterility in 60-100% of the female parasites. These results show that γ-radiation at the dose, intensity, and temperature applied is not lethal to trichinae larvae encysted in meat, but under proper dosage renders the female worms sterile and unable to complete their life cycle. Further experiments are in progress.

206 Radiation effects on the skin and their treatment. Arthur R. Woodburne and Osgoode S. Philpott. J. Michigan State Med. Soc. 48, 461-79(1949) Apr.

A detailed review of studies on 100 patients showing evidence of skin damage due to irradiation is given. Such general effects as erythema, edema, hyperpigmentation, and dry atrophic, and depigmented skin are observed. Severe cases involving large areas of vessels in an obliterative vasculitis and consequent ulceration are cited. Dosages of 5,000-6,000 r over areas of 10 cm diameter or more produce these serious results. Smaller doses of 1,000-3,000 r produce milder symptoms. The pathological changes, involving the vessel walls, collegen bundles, and nuclei are described in detail. Surgery is urged as soon as feasible in order to relieve suffering, permit rehabilitation, and prevent carcinoma.

207 The role of the spleen in radiation injury. Leon O. Jacobson, E. L. Marks, E. O. Gaston, M. Robson, and R. E. Zirkle. Proc. Soc. Exptl. Biol. and Med. 70, 740-2(1949) Apr.

A technique different but related to that previously described by Jacobson et al (Anat. Record 100, (1948); National Nuclear Energy Series Div. IV Vol. 22B) for the study of the significance of the spleen in recovery from or compensation for radiation injury is presented. The materials and methods are described in detail. Radiation consisted of 600 r whole-body x-radiation administered to mice with or without their spleens protected by lead boxes covering all but the pedicles. Hematologic and histopathologic studies were carried out at intervals. The mean hemoglobin, erythrocyte, and hematocrit values of the lead-protected mice were not significantly altered while marked reduction in the unprotected mice was noted. The mean platelet and reticulocyte values of the unprotected group also fell appreciably. These data indicate that severe anemia, leucopenia, and thrombocytopenia develop in mice after a single dose of 600 r whole-body x-radiation. Ectopic erythrocytopoiesis, in the lead-protected spleens compensates with such rapidity and so extensively for the destruction and interruption of this activity in the marrow spaces that no anemia of significance becomes apparent. Ectopic granulocytopoiesis and megakaryocytopoiesis in the lead-protected spleens compensates significantly but at a slower pace and less completely for the bone marrow destruction. A marked and sustained decrease in the amount of lymphatic tissue is produced in the lead-protected spleens. This decrease in lymphatic tissue may perhaps be a result of (a) unsuccessful competition of the lymphatic tissue with the ectopic hematopoiesis for nutritional requirements, (b) actual indirect effect of radiation and (c) a differential humoral suppression from some unknown site. This technic provides a method of studying potential sites and mechanisms of the production of ectopic blood formation, possible secondary effects of radiation as well as offering possibilities for determining the potential role of such sites in immune reactions, in preventing or alleviating radiation-induced hemorrhagic phenomena and in the study of survival or recovery from radiation injury.

208 Sensitivity of the abdomen of the rat to x-radiation. V. P. Bond, M. N. Swift, A. C. Allen, and M. C. Fishler. Naval Radiological Defense Laboratory Report No. ADB-92, Apr. 6, 1949. 16p.

Rats were irradiated either with the abdomen shielded or with only the abdomen exposed. The shields were designed in order to permit equal-roentgen exposures with both types, at any given dose level. A comparison of mortality, survival time, body weight change and gross symptomatology between the two groups revealed distinct differences, suggesting different mechanisms of death referable to the region irradiated. 10 references.

BIOLOGY & MEDICINE (continued)

209 Suppression of gastric acidity with beta particles of $P^{32}$. Norman Simon. Science 109, 563-4(1949) June 3.

Irradiation of the gastric mucosa by x-radiations suppresses gastric acidity, but may also damage more sensitive adjacent organs, such as the liver and small intestine. In order to restrict the radiations to the gastric lining, applications of $P^{32}$ were made, for the $\beta$-particle emission range for this isotope is only about 8 mm. The $P^{32}$ was applied topically to the mucosal lining of the Heidenhain stomach pouches in dogs. A description of the applicator is included, and it was prepared to hold as much as 25 mc of $P^{32}$ absorbed to its surface. The balloon was inserted into the stomach and held there for 2-6 hr. The radiation was followed after a few days by a decrease in total secretion as well as a decrease in the quantity and concentration of HCl in the pouches of all five dogs studied. Two of these dogs had anacid pouches and 3 had hypoacid pouches. Calculated doses of 1,800, 12,000, and 25,000 equivalent roentgens in the first mm of mucosa were given to one animal, while the rest received doses of 20,000-25,000 equivalent roentgens in the 1st of mucosa. The longest period of observation after irradiation of any animal was 125 days. There were no changes in blood count, weight, or general condition of the animals which could be attributed to the radiations. One dog returned to normal acidity after a period of 3 months, and an autopsy showed an ulcer of the stomach pouch.

210 The enhancing effect of the inhalation of hydrogen fluoride vapor on beryllium sulfate poisoning in animals. H. E. Stokinger, N. J. Ashenburg, J. DeValdre, J. K. Scott, and F. A. Smith. AECU-244, Apr. 13, 1949. 23p.

Because relatively large amounts of fluoride have been shown to be present in manufacturing areas where clinical beryllium disease has existed, it seemed reasonable to test the hypothesis that fluoride might contribute to the observed beryllium toxicity. Such a study has been performed in rats exposed either to beryllium sulfate mist or to hydrogen fluoride vapor alone, or to both agents in daily, alternating exposures for one month. The results bases on mortality, weight response and a study of histologic sections of the lungs of these rats were consistent in the various exposed groups and confirm the hypothesis under test, namely, that hydrogen fluoride enhances the toxicity of beryllium sulfate when both agents are admitted through the respiratory route. In addition, it was shown that fluoride is stored in the bone in greater quantities in animals exposed to beryllium than in those animals receiving the same amount of fluoride alone.

211 The inhibition of malic acid oxidation in rat liver homogenates by octin-5-oic acid. James F. Mead. AECU-248, Apr. 15, 1949. 8p.

It has been shown that octin-5-oic acid inhibits the endogenous respiration of rat liver homogenates, although it does not inhibit the oxidation of octanoic acid by this system. It is proposed that the facts can best be explained as inhibition of malic acid oxidation and that further study of the system may increase the knowledge of fatty acid oxidation.

212 Acute dermatitis and pneumonitis in beryllium workers: review of 406 cases in eight-year period with follow-up on recoveries. Joseph M. DeNardi, H. S. Van Ordstrand, and Morris G. Carmody. Ohio State, Med. J. 45, 567-75(1949) June.

This report deals with the acute dermatologic and respiratory tract manifestations of beryllium poisoning that have been encountered in three plants in the Cleveland area. More than 25% of new employees in contact with beryllium inorganic salt fumes and dusts develop skin reactions within 10 days after exposure. Beryllium ulcers are serious problems and may become chronic. They are the result of depositions of minute beryllium sulfate tetrahydrate crystals in the skin through abrasion portals. The present treatment consists of an incision of the papule, removal of the crystals in the acute ulcers, and curettage of the fibrous base in both the acute and chronic phases. The incidence and the mortality of pneumonitis, the severest form of the respiratory tract disorders arising from the beryllium contamination, are the cause of much concern. The irritative phenomena present in these cases are the results of the reactions in the bronchioles of some inorganic salts of beryllium or histamine-like by-products, which cause spasms and partial blocks of the finer respiratory conduits.

BIOLOGY & MEDICINE (continued)

The exchange of gases in the alveoli is slow, resulting in local anoxia, a colloidal imbalance and an alveolar edema. The two main types of pneumonitis are defined and discussed. The treatment of both types consists of hospitalization and the intermittant use of oxygen. The case histories of 20 patients, from the 406 cases on which this paper is based, are given. So far as is known none of the workers who had acute pneumonitis from beryllium have developed recurrences of the chronic conditions such as chronic pulmonary granulomatosis.

213 Effects of feeding uranium nitrate hexahydrate in the diets of breeding white rats. Elliott A. Maynard, Challiss Randall, Harold C. Hodge, and James K. Scott. J. Pharmacol. Exptl. Therap. 95, 421-8(1949) Apr.

Two groups of 50 pairs of rats each were maintained for 7 months on a control diet and on a diet containing 2% of uranium nitrate hexahydrate, respectively. The growth rate of both male and female rats receiving the 2% uranium nitrate hexahydrate diet was notably depressed. An increased growth rate, insufficient to compensate entirely for the previous loss, occurred when the experimental rats were placed on the control diet 7 months after the start of the experiment. Uranium feeding sharply reduced the number of female rats having litters. In addition, the experimental rats had fewer young per litter. When the experimental rats were replaced on the stock diet the females having litters were more productive than the control rats. Females which failed to have litters on the experimental diet did not have litters later on the stock diet. Rats fed 2% uranium nitrate hexahydrate exhibited a slightly greater mortality during the 12-month period, 17% to 10% for the controls. Uranium nitrate hexahydrate feeding produced an irregularity of the oestrus cycle since only 19 of 44 experimental female rats had regular oestrus cycles and regular mating. Uranium, except in traces, does not cross the placental barrier since very little was found in the newly-born of the experimental females upon assay. 11 references.

214 An improved microphotometric apparatus and its use in quantitative histochemistry. N. L. Petrakis, W. R. Lamb, and J. J. Shapiro. Naval Radiological Defense Laboratory, Report ADB-101, Apr. 11, 1949. 11p

An improved, sensitive, and inexpensive microphotometric apparatus for the quantification of histochemical staining in tissue sections is described. A general method for histochemical tissue analysis is presented with a brief comment on the technical factors involved.

215 Improved apparatus for radiobiological syntheses. Clyde A. Dubbs. Science 109, 571-2 (1949) June 3.

A simplified photosynthesis apparatus and procedure, used to prepare $C^{14}$ glucose for poliomyelitis studies, is described in this paper. A sweet potato leaf, 3N $HClO_4$, $CO_2$, and $BaC^{14}O_3$ are used in conjunction with the apparatus presented diagrammatically. In every 24-hr run where the amount of $CO_2$ was not in excess, essentially quantitative assimilation of the available $CO_2$ took place. A simple procedure, based on the fractionation scheme of Hassid, McCready, and Rosenfels (Ind. Eng. Chem., Anal. Ed. 12, 142(1940)), and used in the isolation of $C^{14}$ glucose, is also described. Among the significant improvements summarized, are these: (1) the compact and simplified apparatus saves time and money; (2) no special devices, pre-leaf treatments or temperature controls are necessary; and (3) the evolution of the $CO_2$ within the vessel is rapid but under positive control, eliminating the spattering hazard. The greatest advantage is the adaptability of the apparatus to subsequent fractionation procedures. A minimization of transfers of the samples from the tubes permits small amounts of the material to be handled.

216 The metabolism of the radioactive elements created by nuclear fission. Joseph G. Hamilton. New Engl. J. Med. 240, 863-70(1949) June 2.

A review is made of part of the medical research activities within the atomic-energy program and covering the biological properties and metabolism of the radioactive elements created by nuclear fission. A summary of the metabolism of the principal members of the long-lived fission products (also

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neptunium and plutonium), obtained after parenteral and oral administration in the rat, is contained in one table. Absorption of the products through the digestive tract and the lungs, and retention of the products in the skeletal system and other parts of the body are discussed. The length of retention of some of these products in the skeletal system creates a great radiation hazard. Practical progress in studies developing methods of releasing these products from the bone are discouraging. In conclusion, it is stated that there is no new major mystery surrounding the problem of protection against the radioactive products associated with the release of atomic energy. 15 references.

217 Studies of the acute toxicity of gallium. Horace C. Dudley and Milton D. Levine. Naval Medical Research Institute NM-011-013 Report No. 3, Jan. 13, 1949. 13p.

Rats exposed to aerosols of gallium chloride were effected but slightly in concentrations of 0.125 μg Ga/liter of air in exposures of from one-half to four hours. The acidity of the solution (pH 2.2) of both gallium chloride and the sodium chloride controls produced the effects noted. The minimum lethal doses ($LD_{50}$) of gallium lactate for rats and rabbits is as follows:

| | | |
|---|---|---|
| Rats | Intravenous injection | 46 mg Ga/kg |
| | Subcutaneous injecting | 121 mg Ga/kg |
| Rabbits | Intravenous injection | 43 mg Ga/kg |
| | Subcutaneous injection | 97 mg Ga/kg |

The distribution of gallium in animals receiving injected gallium lactate varies with time, the kidneys initially containing the greatest amount, followed by bone, liver, spleen, muscle, etc. The concentration of gallium falls off rapidly in all tissues except bone, in which the gallium is fixed, and is given up slowly over a period of months. The symptoms resulting from lethal and near-lethal injections of gallium salts may include rapid loss of weight, hyperexcitability, and in some cases photophobia, blindness and terminal flaccid paralysis.

218 Studies of the metabolism of gallium. Horace C. Dudley, George E. Maddox, and Herbert C. LaRue. Naval Medical Research Institute NM-011-013 Report No. 4, Jan. 25, 1949. 12p.

The excretion of gallium is predominantly via the urine, with 85 per cent or more of a near-toxic dose retained in the rabbit more than 10 days. Retention in the liver and kidneys of the rat is moderate for up to 30 days, while bone retains large concentrations of the element for 90 days and longer. Gallium is transported wholly by the plasma, the initial concentration dropping rapidly so that at the end of 24 h a concentration of less than 1 μg Ga/ml is reached. Formed elements show no significant change. It is postulated that gallium may offer a new approach to the study of bone metabolism. Gallium seems to act as a neuromuscular poison.

219 The use of beryllium in New York John E. Silson, Lawrence P. Benjamin, and Samuel C. Wilson. Monthly Rev. of Division of Industrial Hygiene and Safety Standards (New York State Department of Labor) 28, 13-16(1949) Apr.

The uses and hazards of beryllium in industry are reviewed, with particular reference to New York State. The toxic responses to beryllium occur primarily in the lungs, upper respiratory tract, and skin. Two types of respiratory diseases have been noted: one is an acute inflammatory reaction, varying from a mild pharyngitis or bronchitis to a massive pulmonary edema; the second consists of a chronic pulmonary granulomatosis developing after several months to years delay. Cutaneous reactions such as acute dermatitis, skin ulceration, extensively proliferating granulomata, and subcutaneous granulomata have been observed. The neon sign industry, industries handling beryllium alloys, and the ceramics industry employing beryllium experimentally are the sources of beryllium hazards within New York State. Each of these industries is discussed briefly. Control measures within the plants and medical attention, such as physical examinations, are listed.

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220 Instrumentation in the field of health physics. Karl Z. Morgan. Proc. I. R. E. 37, 74-82(1949) Jan.

A short review is given of approximately 30 instruments which are used to safeguard the personnel at the installations administered by the Atomic Energy Commission. The instruments are divided into three categories according to their use: (1) personnel monitoring, (2) area monitoring, and (3) survey instruments. Brief descriptions of the instruments are given, noting the most recent developments, and photographs of several of the instruments are included. 26 figures.

221 Ionizing radiations. Rex H. Wilson. Ohio State Med. J. 45, 579-81(1949) June.

A general discussion of the types and dangers of ionizing radiations encountered in industry is presented. Such precautionary measures as the employment of dental x-ray films to detect exposure and the use of frequent medical examinations to detect abnormal blood counts are mentioned. Lowered white blood cell counts, especially those of the lymphocytic elements, are good indicators of destructive ionization. In conclusion, it is noted that the use of ionizing radiations is a problem which requires close scrutiny on the part of safety, industrial hygiene, and medical personnel.

222 Medical x-ray protection up to 2 million volts (Handbook 41). Natl. Bur. Standards. Mar. 30, 1949. 41p.

Protection procedures and rules for use in connection with x-radiation therapy are listed and discussed. Fluoroscopic, radiographic, and dental units, and mobile diagnostic x-ray units are described and necessary protective measures for each are covered. Structural details of barriers, protective measures for high voltage circuits, and first aid instructions and devices are included. An appendix contains radiation attenuation curves, lists of necessary lead thicknesses for various beam intensities, a distance protection article, and a summary of various dangers not enlarged upon in the body of the book.

223 Radiation hazards in industry. T. H. J. Burnett. Am. Ind. Hyg. Assoc. Quart. 9, 94-7 (1948) Dec.

A general discussion of the protective measures necessary to control exposure to radiation is presented. The difference in permissable exposure doses established in various countries is pointed out. The current maximal exposure dosage in the U. S. is 0.1 r/day. The following steps are useful in the control of radiation exposure: limiting the length of time of exposure; increasing the distance from the source of radiation; using radiation shielding materials: facilitating adequate disposal of radioactive waste products; studying the radiation strength of the material being used; employing various detection devices, such as film badges, and pocket ionization chambers; and using frequent blood counts to determine the effects of large exposures to radiation.

224 Roentgen ray protection and irradiation hazards due to over-exposure. Thomas J. Ho. X-Ray Technician 20, 353-5(1949) May.

A short review of the subject of roentgen ray protection and irradiation hazards is presented. Some of the more important of the injuries are: dermatitis and carcinoma, which may be acute or chronic, the former developing into the latter in cases where skin damage is extensive; sterility, which occurs for about 4 months with a dose of 168 r delivered to the ovaries, and permanently with a dose of 210 r or more; anemia and leukemia; mutation changes, which increase when either of the parents has been irradiated; and, shortening of the life span. The maximum daily doses for the technician and other persons near the irradiated area are discussed. Protective measures, involving the location of the equipment, the alignment of the x-ray tube, protective screens, the determination of the exposure condition, and a search for possible injury are all included and discussed. Mention is also made of the lengthening of the prothrombin time as a means of detecting overexposure to the rays.

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225 Some legal aspects of the artificial radioactivity F. Prevet. Ann. pharm. franc. 7, (1949) Feb (in French).

The problem is discussed of the control to be exercised by public authorities in the commercial handling of artificial radioactive substances. Various legislative measures aiming at the health protection of the public are suggested.

226 The clinical syndrome of irradiations by the atomic explosion P. E. Genaud. Presse. méd. 57, 443-4(1949) May 21 (in French).

A summary of the pathological effects of an atomic explosion on such organs of the body as the digestive tract, the blood-forming organs, the epidermis, and the sexual glands of the human male and female is presented. The clinical characteristics of acute, subacute, and hyperacute radiations are included, and the immediate and remote results are outlined. Further investigations are being carried out on plants, humans, and the Drosophila, but it is observed that no precise statement can be made concerning the permanent effects of such radiations.

227 On the "atomic disease". R. Levent. Gaz. hopitaux 122, 114-5(1949) Mar. 5 (in French).

This is a general survey of data so far acquired on the pathological effects of atomic bomb explosions. The sources used are: Nègre and Bolot, Presse méd. (1948), Jan. 15 and 29; Lacassagne (paper read at Académie Nationale de Médecine on Feb. 17, 1948); and Cronkite and Chapman, Military Surgeon (1949) Jan. A distinction is made between effects of explosions in air, in water, and under soil. Another is based upon the distance from the explosion center. A classification is attempted of various patho-anatomical and clinical pictures of the diseases, mostly fatal, caused by intense irradiation. The preliminary character of our present knowledge in this field, and the complete ignorance of protective and curative measures are emphasized.

228 The pathogenesis of irradiation sickness, Shields Warren. Chicago Med. Soc. Bull. 51, 957-9(1949) May 28.

The syndrome of radiation sickness is discussed as it applies to mass radiation by atomic weapons. The cells of the body which have a short life-span are more affected by the radiation than those with long life-spans, and rapidly dividing cells, or those in mitosis, are more affected than cells in the resting phase. A dose of 400,000 r is usually fatal to about 1/2 of the human population present. There is great variability in the sensitivity of different cells and organisms in general. It is believed that the heaviest types of doses cause disruption in the enzyme systems and vital functions of most of the body cells and death occurs promptly without much evidence of morphological change. Slides are presented which indicate specific and individual reactions to the radiation doses. These include multiple leukopenic abscesses and cellulitis of the neck. The different stages of development of the symptoms are pointed out. If the radiation dose is more than 500-600 r, the chances of survival are small. Future problems connected with mass effective medical care of radiation victims are discussed. Prevention rather than cure is suggested as the most promising method of handling the radiation sickness problem. Lecture with slides.

229 Pathogenesis and therapy of radiation illness. E. P. Cronkite. Med. Ann. Dis. Columbia 18, 239-42(1949) May.

The radiation sickness produced by whole body radiation is discussed from a descriptive and therapeutic standpoint. The syndrome is initiated by protoplasmic injury, through the following mechanisms: (1) enzyme inhibition, particularly sulfhydryl enzymes; (2) some alterations in the osmotic properties and the cell permeability; (3) generalized protein denaturation and (4) an intoxication by histamine-like compounds supposedly liberated as a result of the radiations. There is a reciprocal relationship between the degree and reversibility of the enzyme inhibition, the protein denaturation, and the alterations in osmotic properties and cellular permeability. As the dosage increases, the degree of reversibility decreases and the mortality rises. Complete mortality occurs in the vicinity of 32,000 r in mice. A list of varying degrees of susceptibility of different tissues to necrosis is included.

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Toxic symptoms develop immediately after or during the diffuse radiation. These consist of nausea, vomiting, diarrhea, malaise, etc. and they subside within 24-48 hr. A latent period follows in which leukopenia, thrombopenia, and a slowly progressive leukemia develop. Physiopathologic manifestations involving the adrenal function, the adaption syndrome, the intoxication by histamine-like substances, and bacterial invasion also take place. Finally, the panleukopenia and hemorrhagic symptoms develop 4-6 weeks after the radiation. Capillary fragility and clotting defects also occur. It is suggested that an adequate method of separating hopeless cases from the casualties is essential to conserve time, personnel, and therapeutic agents. Among the specific therapeutic methods which may be used are: sulfhydryl agents to reverse enzyme inhibition; anti-histamine compounds to neutralize toxins; adrenal hormones to replace losses; agents to maintain the water and electrolyte metabolism; prophylaxis treatments of infections in the presence of a granulocytopenia; the prevention and therapy of anemia; the treatment of hemorrhagic tendencies; and means to prevent and remedy the marked loss of tissue and negative nitrogen balance. The use of penicillin, aureomycin, chloromycetin, rutin, and protamine sulfate are also discussed. 14 references.

230 The radiation syndrome. Elizabeth E. Painter and Austin M. Brues. New Eng. J. Med. 240, 871-6(1949) June 2.

A discussion is presented on the theoretical aspects and the clinical manifestations of the radiation syndrome. The initial shock, the acute, the subacute, and the chronic periods are described. The therapy for radiation damage is noted as not being adequate at the present time. It is observed that no single clinical reaction is peculiarly specific for the radiation damage, and many of the delayed effects of radiation can be duplicated by various toxic materials. In conclusion, it is stated that damage to the radiosensitive cells will explain a great part of the picture, but much further understanding of the syndrome is required in the interest of prevention and therapy. 58 references.

231 An exposure meter for radiography. Herbert Friedman and Edward Der Mateosian. Naval Research Laboratory Report NRL-H-2028, Apr. 5, 1943. 16p.

An exposure meter has been developed for use with all penetrating radiations harder than 100-kilovolt x-rays. The sensitivity may be varied to cover exposures from a fraction of a minute to 100 hr with type A film. A built-in standard of calibration is provided to check quickly circuit adjustments, eliminating the need for highly stabilized circuits. The exposure meter utilizes a simple type of intensity measuring circuit.

232 Cancer of the cervix uteri. A study of five to eleven-year end results. William E. Howes. Amer. J. Roentgenol. Radium Therapy 60, 389-402 (1948) Sept.

Two hundred thirty cases with a proved diagnosis of carcinoma of the cervix admitted to the Brooklyn Cancer Institute in the years 1936 through 1941 inclusive are studied. This allows a follow-up of from 5 to 11 years. Classification is made as to race, age incidence, and number of pregnancies. Survival from a pathological and clinical classification is tabulated. The method of treatment is summarized with discussion of the end results and complications, weighed against the particular therapy received. The larger percentage of survivors appears to have been obtained when radium dosage is delivered up to 5.5 erythema doses into the region of the paracervical triangle (parametrium). This is augmented by additional roentgen irradiation approximating 7 erythema doses. The Radium Institute of Paris method of radium administration was used in this series and consists of a three-tube tandem insertion into the uterocervical canal. Various doses of radium are used, but the 4800 mg hr dose is now generally accepted as the minimum effective amount. Additional radiation therapy consists of a wide range of doses with a usual delivery of 4500 r to each parametrium. The complications following the radium therapy may involve the rectum, colon, cecum, bladder, uterus, and kidneys. 17 references.

233 Cancer of the kidney and testicle. Frank Hinman Calif. and Western Med. 69, 290-4 (1948) Oct.

The frequency of testicular neoplasm must be made clear to young men so that they may be treated early. Orchiectomy is necessary in all cases, for diagnosis and determination of subsequent therapy.

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Seminomas are treated with orchiectomy and x-ray while for other tumors the treatment is orchiectomy and radical lymph node dissection. Large doses of x-ray are used in patients with inoperable metastases.

234 Cancer of the larynx; five-year results of radiotherapy. Max Cutler. Radiology 51, 509-19(1948) Oct.

The indications and limitations of radiotherapy in cancer of the larynx and the extent of revision needed in the present treatment are discussed. A study of 107 cases with a minimum observation time of 5 years is the basis of the report. Problems of classification of the carcinomas are noted and criteria for the selection of the proper treatment are listed. The treatment period varies between 4 and 6 weeks, and a total dose of 6000-7000 r is delivered in daily doses through two portals. The average intensity is 7 r/min. For early intrinsic carcinoma, 100 r increasing to 250 r twice daily for 18 days is given. For more extensive intrinsic and extrinsic carcinoma with or without cervical metastases, the treatment is two doses per day, beginning with 85 r and increasing to 275 r, for 18 days. A discussion of various telecurie radium techniques involving the use of 90,000-140,000 mg/hr is presented. Some complications are: the death of the patients before, during, or following the therapy due to their weakened conditions; partial sterilization of deep-seated tumors, with recurrence after carcinoma; and, death from infection, or hemorrhage, due to the extensive destruction of tissue. The results show that out of 107 patients, 37 of them or 35%, survived 5 years. Conclusions are that radiotherapy is indicated in selected cases of laryngeal cancer, since when the cords are freely moveable or only partly fixed by carcinoma the cure rate is high. Laryngectomy is indicated for intrinsic lesions with complete fixation of the cords occurring in subjects who are good surgical risks. 22 references.

235 Cancer of the tongue; a review of 330 cases. Melvin I. Gibbel, James H. Cross, and Irving M. Ariel. Cancer 2, 411-23(1949) May.

A review of 330 cases of cancer of the tongue is presented in which the incidence, etiological factors, pathology, symptoms, metastases, diagnosis, prognosis, and treatment are discussed. Various therapeutic measures such as external irradiation, radon seed therapy, radium needle therapy, surgical extirpation, and combinations of these methods are also discussed. For the smaller lesions of the anterior two-thirds of the tongue, pre-oral irradiation is given, about 350 r/day, at 200 kv until about 6,000 r is administered, after which the equivalent of 5 skin erythema doses is given by interstitial radon. Radon seeds are also used alone, in which cases 8 to 10 erythema doses are given. For lesions of the bases of the tongue, external deep roentgen therapy is given with a 200 kv unit administering 350 r/day and from 3,000 to 4,000 r followed immediately by interstistial radon, for 4 to 7 erythema doses. In lesions which have extensive linear involvment along the margin of the tongue, surgical extirpation is performed. These dosages cover cases in which there are no metastases. Surgery is indicated in cases of lesions with cervical metastases. When a patient presents himself after successful treatment for the primary lesions and is found to have metastases, either of the two methods is used. The metastases may be treated with external deep roentgen therapy consisting of 6,000 r at 200 kv delivered over a period of three weeks. Radon seeds are also placed interstitially in these treatments. The five-year cure rate for these 330 cases is 14.2%. No conclusions are drawn as to the best type of therapy for these cases. 16 references.

236 Cancer of the urinary bladder. Lloyd G. Lewis. Med. Ann. Dist. Columbia 18, 25-8(1949) May.

A review of the symptoms, effects, and therapy of cancer of the bladder is presented in which mention is made of the 1,000 kv x-ray technique, which has proved to be unsatisfactory to the author. For the prevention of new tumor growths and for adequate treatment of existing tumors, the author developed, in conjunction with Dr. Milton Friedman, a method of application of radium element or its equivalent of radon to permit the irradiation of the bladder wall. This method consists of the application of the radium in a Foley ballon catheter distended with 35 cc of colored fluid and centered so as to deliver 1,000 r a day to the bladder lining. An average total dose of 10,000 r to the mucosal surface is used. The resultant radiation effect amounts to a very mild telangiectasia of the mucosa. 13 references.

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237 Carcinoma of the antrum; report of nine cases with a ten-year survey of literature. C. A. Seeling. Ann. Otol. Rhinol. Laryngol. 58, 168-88(1949) Mar.

A review of nine cases of carcinoma of the antrum and a survey of the literature presented in order to determine and outline some of the manifestations leading to early diagnosis. The anatomy, histology, pathology, etiology, and clinical symptoms of the disease are discussed. In the cases presented the indicated therapy is a combination of both surgery and x-radiations. Radiations are given preoperatively or postoperatively and usually are of the 2000-4500 r range. The radiosensitive tumors rarely need only external radiation. 40 references.

238 Carcinoma of the breast. C. D. Haagensen. J. Am. Med. Assoc. 138, 195-205, 279-92(1948) Sept. 18 and 25.

An extensive description of the nature, diagnosis, and treatment of carcinoma of the breast is presented. The first part deals with the problems of diagnosis and the proper methods of examining the breasts by palpation, transillumination, and roentgen rays. The second part includes a section concerned with proving the diagnosis by aspirational and incisional biopsy, and a section covering the treatment of the disease by surgery and irradiation. Palliation with hormone and radiation therapy is also discussed. The fractional dose method is used for the roentgen curative therapy, and consists of giving 100-200 r daily to each of one or more portals, depending on the patient's tolerance. Approximately 2.000 r in air is ultimately given to each portal of the breast and axilla, and the primary lesion in the breast receives 4,500 r. On removal of the breasts and examination after the roentgen therapy, persisting carcinoma cells are always found. Prophylactic radiation usually consists of a total of 1,000 r delivered to each of three portals, given at the rate of 250 r to one or more portals twice weekly. The results of the roentgen therapy are discouraging. As a cure, time radiations do not permanently destroy the carcinoma cells; the prophylactic therapy also is not effective. Radiation therapy is important only as a palliative agent in in-operable cases, which are treated with amounts of roentgen rays up to 6,000 r or more through five portals, administered in small daily doses of 100 r to each of two or three fields. Ten patients out of 31 have survived from 7 to 10 years when treated by this method. Surgery remains the sole reliance for the cure of cancer of the breasts.

239 Carcinoma of the breast; Present Status of Therapy. Howard W. Jones, Jr. Am. J. Surg. 77, 696-704(1949) June.

A description is given of the available therapy for cases of carcinoma of the breast. The radical surgical mastectomy treatment is considered the only major cancer therapy. X-radiations are administered preoperatively and postoperatively in some cases, but it is generally agreed that preoperative irradiation therapy has not added to the total salvage in operable breast cancer. Some cases considered inoperable, and subjected to radiation therapy, have been found afterwards to be in an operable state. A statistical analysis of postoperative radiation therapy results is presented, and discussions of the role of androgen therapy, and the problem of pregnancy following a radical breast operation are included. In conclusion, it is stated that it is not possible to note any improvement in five-year end results from the routine use of postoperative prophylactic therapy. 37 references.

240 Carcinoma of the uterine cervix. Ian MacDonald. Ann. Western Med. and Surg. 3, 126-9(1949) Apr.

Long range results of treatment by irradiation of 56 consecutive patients with carcinoma of the cervix are reviewed. The patients usually were given x-ray therapy, followed by radium treatments, the latter consisting of intra-uterine tandems inserted and retained over 26-40 day periods. The average cure rate over a five-year period was 51.7%, and complications occurred in only a few of the patients, these consisting of transient proctitis and cystitis, and serious sequelae.

241 Epithelioma of the penis. George H. Ewell South Surgeon 14, 715-30(1948) Oct.

The nature and treatment of epithelioma of the penis are given. Irritation from retained secretions beneath a phimotic prepuce is assumed to be the cause of this condition. Circumcision is a

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strong protective measure. Treatments of the primary lesions on the penis by radium and surgery are satisfactory measures in about two-thirds of the cases. The treatment of groin metastases has been improved by refinements in the x-ray therapy technique.

242 A few observations taken from treatments of cancer of the breast with x-radiations associated with halsted's operation. Bengt A. Nohrman J. Radiol. Electrol. 29, 403-8(1948) (in French).

A histological classification of 769 cases treated at the Radiumhemmet with x-rays in connection with radical mastectomy and exaeresis of the axilla during the years 1939-1941 is described. The importance of different factors is discussed. These include the degree of extension of the axillary metastases, age and death of intercurrent diseases, menopause, selection of the cases, x-ray treatment before and/or after the operation. Mention is made of dosages of 350 r. The conclusion is that the pre-operative x-ray treatment makes the prognosis better in the group which comprises the cases with the worst prognosis. 8 tables.

243 Hypertension treated by irradiation of the adrenals; with report of twenty-three cases. Arthur S. Alexander and Richard W. Young. New Orleans Med. Surg. J. 101, 536-41(1949) May.

The results of experiments to evaluate the findings of previous investigators concerning the possibility that adrenalin discharges may be involved in the pathogenic mechanism of angina pectoris are summarized. Twenty-three cases are the basis of the investigation. Recent experiments by Raab and Soule show that irradiation of the adrenal glands by single doses of 100 and 1000 r cause slight changes in the content of adrenalin and related catechols in the glands within two months. A summary of the various effects of adrenalin on the body is included. Present investigations include irradiation of the adrenal glands and the lower dorsal sympathetic chain through a technic involving the use of 250 kv at 15 ma, 50 cms target skin distance using a filtration of 1 mm of Cu plus 1 mm of Al. The patient is given 6 successive treatments alternating the right and left sides so that each treatment involves 250 r. Nausea is the main complication. The four main contraindications to therapy of this sort are: symptoms of primary adrenal insufficiency, coronary thrombosis, tuberculosis of the kidney or peritoneum, and cardiac decompensation. Vascular hyperreactive cases, latent hypertension cases, essential hypertension cases, and secondary hypertension cases are covered. The results show that the most striking relief is in the patients suffering angina pain. They are relieved of pain for a long period of time or permanently. Complete alleviation in 12 subsequent cases of postcoronary anginas, Buerger's disease, and vascular hyperreactives are reported. 15 references.

244 Indications of roentgen and radium therapy. Herbert Schoen. Forum Medicinale No. 2 (in German).

This small book is written for the practicing physician and describes the uses of roentgen and radium therapy, and, in concise order, the principles and effects of administration of these rays. A non-technical style is used. One application discussed is the roentgentherapy of tumor cases. Possible uses and manners of administration of this therapy are given. A short section covers the biological effects of radiations, the natural as well as artificial radioactivities, and the origin and treatment of ray destruction and sickness.

245 Malignant lesions of the face and ears. George K. Henshall and Walter W. McCorkle. Jefferson-Hilman Hosp. Bull. 3, 83-90(1949) Apr.

This study is an analysis of 219 cases of biopsied malignancies of the skin, face, and ears that were identified and treated in the University Tumor Clinic of the Medical College of Alabama from the period of January 1, 1948, through March 31, 1949. The study represents only those cases which were proven malignant by biopsy and were subsequently treated by x-radiations, except two cases of malignant melanoma which were managed surgically. The group was treated with superficial x-radiations generated at 100 kv, with 5 ma, a 1-mm Al filter, and 16 cm STD. Basal cell lesions

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received about 100 r units daily for a total of 5,000 r, and baso-squamous and squamous cell lesions received 1000 r units daily for a total of 6,000 r. Agents known to cause a pre-disposition for skin cancer are discussed. The age of the patients and the location of the various malignancies are pointed out.

246 Malignant lesions of nasal fossae and sinuses. Diagnosis and treatment. Austin T. Smith and Theodore P. Eberhard. Penn. Med. J. 52, 932-6(1949) June.

The diagnosis and treatment of malignant lesions of the nasal fossae and sinuses are discussed and three typical cases are presented. The therapy is irradiation, and is individualized to the case. It is stated that at least 5,000 tissue roentgens are probably needed to control the average tumor. The amount of time taken for the delivery of an adequate 7,000-8,000 r dose is emphasized. Early diagnosis is concluded to be very important for the prompt cure of these malignancies.

247 1948 year book of radiology. Fred Jenner Hodges and Ira I. Kaplan. The Year Book Publ. Chicago, 1948 472p.

This book is divided into two parts, part one dealing with radiologic diagnosis, and part two dealing with radiotherapeutics. Separate chapters are devoted in part two to radiation biology, radiation physics, radiation in general medicine, radiation in neurology, radiation in ophthalmology, radiation in dermatology, radiation in otolaryngology, radiation in chest conditions, radiation in breast conditions, radiation in gastrointestinal conditions, radiation in gynecology, radiation in gentiourinary conditions, radiation in bone conditions, and radiation in injuries and trauma.

248 On a peculiar late reaction in radiologically treated cases of cancer of the hypopharynx. Sölve Welin. Acta Radiol. 30, 249-56(1948).

In five out of 95 cases of cancer of the hypopharynx which were treated with radiations a peculiar late reaction was observed at subsequent checkups. This consisted of a vertebral soft-tissue shadow and a ragged appearance to the mucous membrane on the x-ray films taken at the time. These outward appearances, indicative of carcinoma, fluctuated in severity and presence during the 6-month intervals at which x-ray follow-up films were taken. The tumor doses which had been delivered to the patients during the carcinoma therapy were 900-1700 r over a period of 28-45 days. Upon investigation clinically, the presence of a locally recurrent carcinoma in each of these cases was refuted. The conclusions are that these changes were caused by a late reaction of the irradiated tissue to some intrinsic factor, such as an infection.

249 Operable and inoperable cancers of the breast treated by roentgen therapy alone. F. Baclesse. J. Chirurgie 64, 550-1(1948) (in French).

This is a short report on 145 cases of breast cancer treated by x-rays alone in the Fondation Curie, Paris, France, in 1936-1945. The material is not sufficient to allow any final conclusions; however, it can be advanced that Roentgen therapy alone, when applied according to a certain technique (high doses, protracted treatment) can result in a clinical disappearance of the tumor, of the calavicular adenopathy, and, in a lesser degree, of the axillary adenopathy. This statement, which concerns only regional clinical pictures, has no bearing upon the question of the possibility of a distant metastasis. The technique is difficult, the treatment long and expensive.

250 Radiation myelitis of the cervical spinal cord. Geoffrey Boden. Brit. J. Radiology 21, 464-9(1948) Sept.

One hundred and sixty-one cases that received radiation of the cervical cord at therapeutic dosage levels were investigated for the incidence of radiation myelitis. Ten cases of progressive or transient myelitis were found to be the result of radiation doses of 2876-4375 r over 4-17-day periods in large field therapy, doses of 2000-5500 r over 1-17 days for small field therapy of the tumor, and doses of 2000-5200 r in 1-17 days for small field therapy of the cord. Six of the progressive lesions resulted in five deaths, and four of the lesions were transient. The interval between treatment and onset of

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symptoms was approximately 12 months, in agreement with a few previously recorded cases. The symptomatology of radiation myelitis is described, and the diagnosis and differential diagnosis discussed. It is suggested that relatively long lengths of cervical cord should not receive more than 3500 r in 17 days and that the administration of 5000 r in 17 days, or 2000 r in 1 day, the approximate lethal dose level for squamous carcinoma, to even short lengths of cervical cord is likely to lead to permanent damage in some cases. When it is necessary to irradiate tumors situated near the spinal cord, the dose that the latter receives should routinely be estimated and should be kept as low as possible. 3 tables.

251 Radiation therapy of eye diseases. Melville L. Jacobs. Ann. Western Med. and Surg. 3, 68-9(1949) Feb.

The successful treatment of eye diseases by radiation therapy is presented. $\beta$-radiation dosages employed usually consist of emissions from a Burnam applicator for 4-6-g seconds at 14-day intervals. Tuberculosis of the anterior segment, vernal catarrh, corneal scarring, granulation tissue, pterygium, pseudopterygium, recurring pterygium, and symblepharon may be treated by this method. A second group of diseases responds without consistent results to $\beta$-radiation. Neoplastic diseases are treated with x-radiation, usually of 200 or 250 kv or with radium applications. With suitable modification in the apparatus, pure $\alpha$ and $\gamma$ rays may be obtained for the treatment of benign neoplastic lesions and malignant lesions such as carcinomata, hematopoietic and lymphoid lesions, and orbital tumors.

252 Radiotherapy in cancer of the uterus. L. Martindale. Med. Press 220, 223-7(1948) Sept. 22.

The results of treatment of cases of cancer of the uterus by radiotherapy are given. The cases are divided into 4 stages according to the severity of the conditions. In cancer of the cervix the mortality rate in stages 1 and 2 is 0-1%. In late stage 2 and stage 3 cases radiotherapy results in well equipped clinics vary from 30 to 60% effective. In stage 4, many of the symptoms are ameliorated and about 7% of such cases survive 5 years or more. The results are good for the 4 stages with this therapy. In cancer of the corpus, it is concluded that the best method is still debatable. Surgery and radiotherapy are indicated by the degree of severity of the individual case and in certain cases a combination of radium and x-ray therapy is concluded to be the best form of treatment.

253 Radiotherapy and malignant disease. W. A. D. Drummond. J. Roy. Army Med. Corp. 92, 139-46(1949) Mar.

A list of 108 tumor cases presented for treatment during 1948 at the Radiotherapy Department of Westminster Hospital by arrangement with the Queen Alexandra Military Hospital and the Director and Consultant Surgeon is included in which the total range of radiation is wide and the type of radiotherapy is variable. Both benign and malignant tumor conditions are covered. The author describes the improved medical system by which service personnel and their families are given immediate tumor therapy.

254 Radium therapy for carcinoma of bartholin's glands. Harry H. Bowing, Robert E. Fricke, and Thomas J. Kennedy. Am. J. Roentgenol. Radium Therapy 61, 517-29(1949) Apr.

Seven cases of carcinoma of Bartholin's glands and the radium and roentgen therapy indicated for these cases are described. The location of the glands and the symptoms signifying pathological involvement are outlined. Each case is extensively presented; radium therapy was applied in varying dosages in all cases, and x-radiations were used as supplementary therapy in 3 cases. Four patients are known to have died of the disease. The conclusions are that: (1) carcinomas of the Bartholin's glands are rare; (2) low grade carcinomas treated by prophylastic radium therapy should not recur; (3) extensive carcinomas treated with radium may not recur; and (4) surgery, radium therapy and x-ray therapy combined constitute effective methods for control of these carcinomas. 36 references.

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255 The results of smallest roentgendoses in cases of inflammations. Wien. med. Wochschr. 1/2 (1949) (in German).

The results of 500 cases of various diseases treated with roentgenradiation are described. Furuncles, carbuncles, acute sinusitis and epicondylitis cases received 3-30 r daily of the weakest possible rays, 23-28 kv. There are only a few unfavorable cases. Especially impressive is the rapid diminution of inflammed swelling during total doses of over 50 r and arrestment of cell destruction. Eczema needs higher doses, because the inflammed epithelial cells react differently. Acute hydrosadenitis is arrested by 2-6 applications of 5-10 r, followed by somewhat higher dosages until 80 r is delivered 3 times; then, prophylactically, 5-10 r 1-2 times weekly for 6 times. Extended work with arthritis and nephritis is being done. The results with vasomotor rhinitis, and allergenic asthma are being made clear. With small repeated doses roentgen resistence can be built up and regeneration stimulated. The changes in the lymphatic system can be traced hematologically and histologically.

256 Results of x-ray therapy of cancer of the larynx. V. Svàb, A. Preiss, and J. Z. Rezek. Časopis Lékáru Českych 87, 989-92(1948) (in Czech).

The results of protracted and simple fractionated irradiation on 218 cases of laryngeal carcinoma is described. Of the patients treated, 79 had to discontinue the doses, 62 were cured, 6 of which had local recidivations. No evident differences were found in the results of the two methods used. The simple fractionated irradiation was best conducted with 180 kv and 10 ma, using 1-mm Cu and 1-mm Al filters, the FSD being 50 cm, and the field covering 6 by 8 cm. The maximum daily dose of 260 r, delivered at the rate of 17-18 r/min was divided equally and separately between 2 fields with the lapse of 4-6 hr between each radiation. If the roentgen dosage of 5000-6000 r did not completely remove the tumor, treatments were continued to a total of 8000-10000 r in 7 weeks. Surgical and x-ray treatment of laryngeal carcinoma appear to be the best available therapy.

257 The role of radiation in the treatment of cancer of the breast. J. Maisin. J. Radiol. Electrol. 29, No. 7-8(363-402(1948) (in French).

A comprehensive review of the role of radiation therapy in the treatment of breast carcinoma is presented. Pre-operative and post-operative therapy is discussed. The numerous dosage levels used by previous investigators are included in this article as well as a detailed analysis of surgical statistics and on evaluation of hormonotherapy and castration procedures. The average patient survival 5 years after treatment by Halsted's surgical method is 35% of the combined 1st and 2nd classes of the carcinoma. Post-operative radiotherapy distinctly improves surgical results since for both 1st and 2nd period cases the average survival for the 5-year period was increased to 50%. 45 tables. 87 references.

258 The role of radiotherapy in the treatment of malignant disease. A. B. Wayte. Guy's Hosp. Gaz. 63, 188-91(1949) June 18.

A general discussion of the uses of radiotherapy in the treatment of malignant disease is presented. The amount of irradiation normal tissues are capable of withstanding, according to the author, depends on the nature of the tissue, the volume of tissue irradiated, and the blood supply. Radiotherapy as the treatment of choice is listed for a number of malignant diseases in this report. The diseases for which radiotherapy is an alternate method or for which it is of no use are also listed. In the latter category appear fibrosarcoma, myosarcoma, liposarcoma, melanoma, and carcinoma of the stomach, bowel, and prostate.

259 The role of x-ray therapy in nontumorous conditions. M. Paul Mains. J. Med. Soc. New Jersey 46, 287-91(1949) June.

A general review is presented of the uses of x-radiations in the treatment of skin diseases, neurologic disorders, diseases of the skeletal, lymphoid tissue, vascular, and respiratory systems, mastitis cases, gastro-intestinal lesions, and genito-urinary disorders. No dosages are given. Contact dermatitis, dermatitis venenata, neuro-dermatitis, toxic dermatitis, and trophic dermatitis are

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affected by x-radiations. The irradiations are also effective in psoriasis, hemangioma, pruritis, and bacterial infections. Radiations in non-tumorous conditions of the skeletal system are confined to joint cases. For neurologic disorders the rays have an analgesic effect; in this connection, paravertebral irradiation in the acute stage of Herpes Zoster is mentioned. Since lympoid tissue is very sensitive to the rays, good results have been obtained on patients with adenoids, ear infections, colds, and sinusitis arising from infected naso-pharyngeal lymphoid tissue. The radiations are frequently employed in cases of virus pneumonia, asthma, the acute post-partum and chronic forms of mastitis, paroritis, and plastic induration of the penis. It is concluded that greater use of radiation treatments for the more common ills will improve the rate and speed of recovery of patients.

260 Some factors influencing response of cancer to radiation. Constance A. P. Wood. J. Amer. Med. Assoc. 140, 513-20(1949) June 11.

A discussion of the factors involved in the treatment of cancer by radiation is presented. Several cases of epithelioma of the oral cavity are cited and the dosage levels given. The importance of tumor differentiation in these cases is stressed. There was no difference in the effects of rays of different wavelengths on the tumors. It is concluded that it may be necessary to initiate entirely different treatments and dosages for different types of epitheliomas arising in the same site, and that further improvements in physical technique are unlikely to bring about better results in cancer cases without due regard to tumor biology. It is thought that advancement in knowledge of the fundamentals of radiobiology leading to a better understanding of the action of radiation on the living cell offers the greatest possibility of any improvement in the radiation treatment of malignant disease.

261 The treatment of carcinoma of the cervix uteri. A. Maxwell Evans. Can. Med. Assoc. J. 59, 458-62(1948) Nov.

A discussion of certain points of the natural history of carcinoma of the cervix, a review of some of the published literature, and results of radiation therapy of this disease are included. Radium treatment, involving a modified Stockholm procedure, and x-ray therapy are used. The total radium dose is 5,500-8,600 mg/hr over a period of 3 weeks. The x-ray dose is 2800-3500 r delivered to the parametrium. Thirty-one per cent of the 126 patients studied survived 5 years after the therapy. The incidence of patients with advanced carcinomas is high, indicating that earlier diagnoses are important. 20 references.

262 The treatment of human thyroid disease with radioactive iodine. J. B. Trunnell. Trans. New York Acad. Sci. 2, 195-201(1949) Apr.

A general summary of the terms used, the theory involved, and some of the problems and factors concerned with the use and application of radioisotopic work is presented. A discussion of the problems and uses of radioiodine is also presented in which the isotope's role in the treatment of various thyroid diseases is stressed. Doses of 4-12 mc, with a total deposition of 150 mc/g thyroid tissue, are employed in treating hyperthyroidism, and doses of 50-300 mc are used in treating thyroid carcinomas. It is noted that radioactive iodine should not be employed as the only or first therapy in early or uncomplicated cases of thyroid malignancy; radical surgery is the most satisfactory initial therapy. In cases where distant and extensive metastases are present, doses should be calculated to deliver the equivalent of no less than 6000 r to the metastases. The goal should be, however, 40,000 r because of the unavoidable loss due to excretion, etc., of the radioactive substances. Four procedures are mentioned as improving the ability of the metastases to pick up the iodine: thyroidectomy, the administration of relatively pure thyrotrophin in doses of 30 mg/day, the use of thiouracil over long periods of time, and prolonged high grade water diuresis. It is concluded that the entire subject is still in the earliest stage of development, and all tentative conclusions formed are subject to change.

263 The uptake of radioactive phosphorus by malignant brain tumors. Theodore C. Erickson, Frank Larson, and Edgar S. Gordon. J. Lab. and Clin. Med. 34, 587-91(1949) May.

The results of experiments to determine whether glioblastoma multiforme, by virtue of its rapid growth, might manifest an avidity for circulating inorganic phosphate that would make it possible to

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secure significant intracellular concentrations of $P^{32}$ are described. Doses of either 5 or 10 mc were injected into patients with malignant brain tumors in three different ways. Biopsy tissue taken at intervals with tested for radioactivity. Results show an increase of 16:1 up to 29:1 in radioactivity in the tumor tissue over that in the normal brain. Chemical fractionation of tissue phosphorus showed a small but significant concentration in the nucleoprotein of both cytoplasm and nucleus. The implications of these findings are discussed. It is stated that in any clinical use of $P^{32}$ the capacity of normal, metabolically active tissues, especially bone marrow, to withstand the radiation will be the limiting factor.

264 Use of isotopes in man. Austin M. Brues. Chicago Med. Soc. Bull. 51, 954-7(1949) May 28.

A general discussion of the uses of radioisotopes for experimentation and therapy is presented. Among the newer methods of treating patients, $P^{32}$ is mentioned as a valuable agent for the treatment of diseases of the blood-forming organs. The effects of radioarsenic, As-76, in certain blood dyscrasias and in Hodgkin's disease are pointed out. The role of $I^{131}$ in thyroid metabolism and treatment and the future of such tracer elements as $C^{14}$ are discussed. It is noted that the use of these isotopes is being given as much encouragement as possible.

265 X-ray treatment of functional uterine bleeding. R. F. Sethna. J. Indian Med. Assoc. 18, 67-8(1948) Dec.

The treatment of functional uterine hemorrhages by x-ray radiation is presented with particular reference to 3 age groups. Techniques used are either that of Edeikin, consisting of 135 kv and 65 ma, at 40 cm distance with a 6 mm aluminum filter, and a delivery of 50 to 90 R/U, or that of Kaplan, 200 kv higher voltage radiation, at 40 cm distance, with 0.5-mm Cu and 1-mm Al filters, through fields of 8 × 10, 9 × 12, or 10 × 15 cm, with a delivery of 75-100 R/U. In the mature age group, 20-40 years old, 24 to 25% of unit dose (144 to 150 R U) is given. This still provides a good chance for pregnancy after endometrial healing. In patients above 40, radiation sickness sometimes occurs after treatment of 625-725 R/U in graduated doses, and is best treated by administration of vitamin $B_6$, vitamin C, and vitamin K. In young girls less severe dosages are given after milder therapy fails. Mortality is nil when x-rays are used and there are no post-radiation complications such as leucorrhea, pyometra, and stenosis of the cervical canal.

266 Determination by means of radioactive blood corpuscles of the crossed blood flow between parabiotic mice. Jørgen Bichel and Ib Holm-Jensen. Acta Physiol. Scand. 17, 255-60(1949).

Studies designed to evaluate the rate of exchange of blood between homogenetic and heterogenetic parabiotic mice, through the use of red blood corpuscles labeled with $P^{32}$, are given. The methods and calculations, and results are listed. The radioactive blood was prepared by mixing 0.05 ml of a nearly isotonic, neutral solution of labeled sodium phosphate with 0.5 ml of blood prepared previously with epinephrine. The mixture was agitated, stored for 2-2½ hr, then injected. The results demonstrate that the rate of exchange of blood between homogenetic parabions considerably exceeds that between heterogenetic parabions; the mean rate of exchange in the former being 90% of the blood volume of one animal, the latter being only 2%. This difference is not due to agglutination.

267 The distribution of radioactivity in rats after administration of $C^{14}$-labeled methadone. Henry W. Elliott, Frances N-H. Chang, Ismail A. Abdou, and Hamilton H. Anderson. J. Pharamacol. Exptl. Therap. 95, 494-501(1949) Apr.

Experiments on the absorption, distribution, and excretion of methadone, 6-dimethylamine-4-diphenyl-3-heptanone hydrobromide, labelled with $C^{14}$ in the 2-position are described. This preparation when compared with a commercial non-radioactive product produced equivalent biologic responses in rats. Ten mg/kg produced analgesia with persisted for at least 3 hr, accompanied by the loss of the righting reflex for 2 hr, and by postural rigidity, respiratory depression, and the Straub reaction.

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Six young female rats of the Slonaker-Wistar strain weighing between 106-158 g were used in these studies. Each was given 10 mg/kg of labelled methadone by subcutaneous injection into the left hind leg. Animals were sacrificed 1, 2, 3, and 24 hr after the injections and they were prepared for radioactive assays. The results indicate tissue specific activity values are comparable to methadone concentrations. The possibility that methadone is conjugated in the body has not been completely excluded. Labelled methadone HBr is rapidly and completely absorbed after administration by the subcutaneous route. At periods of from 1-3 hr after administration, the specific activity of the brain was no higher than carcass levels, thereby indicating no particular affinity of central nervous system tissue for labelled methadone. Concentrations well above carcass levels were found in the adrenals (at 1 hr), thyroid, lungs, spleen, kidneys, liver, and gastro-intestinal tract. Labelled methadone HBr is almost completely excreted after 24 hr and excretion is primarily via the intestinal route and secondarily via the kidneys.

268 Experiences with radioactive isotopes. Gustav Nylin. Schweiz. med. Wochschr. 78, 1016(1948) Oct. 16.

Studies involving the use of blood cells marked with $P^{32}$ in order to measure the amounts and velocities of blood are outlined. The method of preparation of the radioactive corpuscles consists of that of Hevesy and involves using a specific amount of $P^{32}$, approximately 0.06 mc, and agitating it for 2 hr at 37°C with 8 $cm^3$ of blood. The coefficient varies between 0.30 and 0.80. The procedure is described fully. The activity of the corpuscles and plasma is measured with a Geiger-Müller counter. Two methods are used, the dessication and the dry techniques, the first yielding 6.4% error and the second 3.4%. The residual blood pool of the heart was studied, and mixing time curves on normal and abnormal hearts are plotted and described. The corpuscles retain their activity for long periods of time during the experiments, while plasma activity is soon dissipated. The schock problem, the actions of muscles and chemical stimuli on blood reserviors, blood volumes and circulation in various organs, and the decompensation action of the heart can be investigated with these methods.

269 Indicator investigations with radio-copper on alimentary anemic rats. Gerhard Schubert, Werner Maurer, and Wolfgang Riezler. Klin. Wochschr. 26, 555-7(1948) Sept. 15 (in German).

Sixteen rats were each injected in the back region with .005 mg of radioactive copper contained in the form of copper sulfate in order to determine the absorption of copper in alimentary anemic rats. Control animals were used as comparisons, and the results indicated that the radio-copper capacity of the blood plasma was only half as high in the anemic animals as in the controls. This condition was interpreted through the bindability of the endogenous copper ions on the basis of the catalytic activity of the blood.

270 Investigations with radioactive penicillin. P. D. Copper and D. Rowley. Nature 163, 480-1(1949) Mar. 26 (Letter to the editor).

Some investigations with radioactive penicillin which were made to determine the nature of the primary reaction between penicillin and the cell are described. It was found that the self-absorption of $\beta$-rays by the bacteria can be eliminated by counting thin films of bacteria, thus changing the anticipated results from those of previous experiments (Rowley et al., Nature 161, 1009(1948)). Bacteria were suspended under various conditions in radioactive penicillin solutions, centrifuged, washed, and the radioactivity on the bacteria measured directly by the Geiger counter. The curve of penicillin uptake of resting staphylococci as a function of the concentration of penicillin in the environment is shown. The penicillin uptake was very small, varying from a maximum of 40 units per g dry weight down to the smallest detectable amounts of 0.5 units per g and was taken up by all bacteria in amounts which increase with penicillin concentration in the external environment. In the range of 0-0.5 u/ml, however, a marked qualitative difference in the shape of uptake curve for sensitive and resistant organisms was noted. At these minimal concentrations, much more penicillin is fixed by sensitive than by resistant bacteria. A curve of the rate of penicillin uptake for actively dividing staphylococci is

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also given; this curve indicates that the uptake increases greatly when growth occurs in the presence of penicillin. However, if growth is halted by cooling, or if the cells are already dead, there is still a rapid but smaller uptake. The penicillin is strongly and irreversibly attached under all conditions of reaction, and cannot be removed by washing by numerous reagents; it is, however, removed by heating for 5 days at 60°C in water. The authors conclude that rapid growth exposes more centers in the bacteria with which the penicillin can react and that the combination must either be by unusually strong adsorptive or by chemical forces.

271 Rate of flow of venous blood in the legs measured with radioactive sodium. H. Payling Wright, S. B. Osborn, and Denise G. Edmonds. Lancet 2, 767-9(1948) Nov. 13.

A direct method of measuring the rate of venous blood-flow in the legs of humans, through the use of the radioactive isotope $Na^{24}$, is described. The method of preparation of the $Na^{24}$ compound is given, and consists of partially converting NaCl into $Na^{24}Cl$ by neutron radiation. The dry crystals are assayed for activity, then placed in a sterile solution, so that the activity per ml is 10-20 mc. A group of 121 normal people were tested for their foot-groin venous flow time under standard conditions by the procedure described. The mean flow time was $18 \pm 0.9$ sec and the extreme range of the observations was 4-50 sec. The accuracy of the method is discussed and a comparison is made with the findings obtained using other methods. 13 references.

272 The rate of renewal in woman of the water and sodium of the amniotic fluid as determined by tracer techniques. G. J. Vosburgh, L. B. Flexner, D. B. Cowie, L. M. Hellman, N. K. Proctor, and W. S. Wilde. Am. J. Obstet. Gynecol. 56, 1156-9(1948) Dec.

The rate of passage of water and sodium from the maternal circulation to the amniotic fluid has been measured with heavy water and radioactive sodium as the tracer substances. The water of the fluid is completely replaced on the average of once every 2.9 hr; this considerable rate of turnover is at variance with the concept that the amniotic fluid is stagnant. The rate of transfer of water is about five times more rapid than that of sodium. 2 tables.

273 Recovery of isotopic succinate from urine of rats administered isotopic acetate. Jui Shuan Lee and Nathan Lifson. Proc. Soc. Exptl. Biol. Med. 70, 728-30(1949) Apr.

Isotopic acetate was fed to rats to determine its metabolic fate and to verify the evidence that the Krebs or tricarboxylic acid cycle enters into the acetate metabolism as a pathway. The methods used for these determinations are described. It was found that the labeled carbon of the acetate eventually appeared in succinate in the urine. The location of the isotope corresponded to that predicted by the tricarboxylic acid cycle. This confirms additional evidence that the metabolism of the acetate proceeds along the tricarboxylic acid cycle with succinate as one of the intermediate steps.

274 Studies of the eye with radiosodium autographs. Ludwig von Sallmann, Titus C. Evans, and Beatrice Dillon. Arch. Ophthalmol. (Chicago) 41, 611-26(1949) May.

Radioautographic technics were applied to studies of the movement of $Na^{24}$ in the eye, a gross method being used for frozen slices and the microscopic method of Evans for thin paraffin sections of the eye. To study the entrance of radiosodium into the ocular fluids from the blood, interperitoneal injections of 0.6-0.8 mc/kg body weight of a solution containing radiosodium were given to rabbits, cats, a dog, and a monkey. Phases in the penetration of the tracer substance from the blood into the fluids of the eye were made visible. The regions of the ciliary body and of the optic nerve were shown as the main portals of entry. Diffusion through the capillary walls was found to be the predominant factor in this process. Cyanide as a specific inhibitor of energy-providing reactions was employed to determine the existence of a second factor operative in the transport of $Na^{24}$ from blood to the eye, that is, of active transfer by the barrier membranes of the ciliary processes. There was suggestive evidence that such a mechanism operates in the movement of sodium across the barrier membranes of the ciliary body. Diffusion of $Na^{24}$ in the vitreous and anterior chambers occurred at a rapid rate after an intravitreal injection of 0-60 mc of the radioactive substance in 0.025-0.06 ml.; the $Na^{24}$

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movement in the living eye exceeded that in the enucleated globe. Comparison of the radioautographs in the two sets of experiments supports the theory of through and through circulation of the tracer ion in the living eye. The problem of absorption of electrolytes by the ciliary body was studied with $Na^{24}$, both methods of radioautography being used. A conspicuous accumulation of the tracer was observed in the ciliary processes after intravitreal injection, but no final conclusions could be drawn with regard to the nature of this phenomenon. The influence of an applied electric field on the movement of $Na^{24}$ in the eye was made visible by radioautography. Various types of iontophoresis were studied. None of them was suitable for the introduction of regularly substantial quantities of the tracer into the vitreous space, even though such technics did demonstrate appreciable penetration into the anterior chamber of normal eyes and into the vitreous space of aphakic eyes.

275 The study of peripheral vascular disease with radioactive isotopes. F. W. Copper, Daniel C. Elkin, Patrick C. Shea, and E. W. Dennis. Surg. Gynecol, and Obstet. 88, 711-8(1949) June.

An evaluation of the second of two radioisotope methods used in the study of peripheral vascular disease is presented in this section. Section one (1) deals with the use of radiosodium-24 by two methods, the first of which is described in detail, and a discussion of the electronic apparatus used. The method presented here is the second mentioned in section (I) and is given in detail; it consists of injections of sterile solutions of radioactive sodium chloride into the muscle extremity to be studied. The radiation emanations are readily detected by electronic equipment placed outside the body. Fifty-seven normal individuals were studied by this method. Under basal conditions the disappearance of sodium from the muscle in a given individual is constant. A list of the factors controlling the rate and the volume flow of blood are included. One hundred and two patients with peripheral vascular disturbances were also tested, and curves representing the rate of disappearance of the sodium from the muscle were plotted. These curves give accurate statistical patterns. It is believed that this method of study may offer valuable aid in the avaluation of certain forms of therapy which are believed to enhance the circulation.

276 The use of radioactive isotopes in immunological investigations. 2. The fate of injected $P^{32}$-containing proteins. T. E. Banks, J. C. Boursnell, Hilary M. Dewey, G. E. Francis, R. Tupper, and A. Wormall. Biochem. J. 43, 518-23(1948).

$P^{32}$-containing proteins have been used to study the fate of intravenously injected antigens. The antigens used were lipovitellin and vitellin obtained from eggs laid by hens injected with $P^{32}$-containing inorganic phosphate, and artificially phosphorylated human serum proteins. The injected proteins quickly disappeared from the blood stream. Less that 1/4 of the injected phosphorylated human serum proteins was detectable in the blood 3 hr after the injection, and the disappearance of vitellin and lipovitellin was even more rapid, since only about 1/8 of the injected protein could be detected in the blood 5 min after the injection. Appreciable amounts of $P^{32}$ were found in the liver and lungs of two rabbits 1 min after the injection of a suspension of vitellin. Two tables listing the $P^{32}$ content of whole blood, cells, and plasma of rabbits following the injections are given. 23 references.

277 The use of tracer doses of radioactive iodine, $I^{131}$, in the study of normal and disordered thyroid function in man. Sidney C. Werner, Edith H. Quimby, and Charlotte Schmidt, J. Clin. Endocrinol. 9, 342-54(1949) Apr.

The results of a survey concerning the uptake by the thyroid of tracer doses of radioactive iodine, $I^{131}$, during normal and disordered thyroid gland function in man are presented. A number of disorders are covered, among which are euthyroidism, hyperthyroidism, other thyroid disorders, pituitary and adrenal disorders, nutritional disorders, and endocrine disorders. The normal dose administered was 40-100 mc. The methods, data and results are included. The normal range of uptake is between 10% and 35-40% of the administered dose at 24 hr. There is a small but significant overlap of uptake between the control subjects and patients with toxic goiter. In cases of toxic goiter, the general correlation which exists between iodine uptake by the thyroid gland, and hormone secretion as reflected by

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the basal metabolic rate, can be disrupted by the treatment of the thyrotoxicosis. Lack of correlation between iodine uptake and basal metabolism may be found in active thyroiditis, malignant exophthalmos, Simmonds' disease, Addison's disease, and anorexia nervosa. The depression of iodine uptake by previously administered thyroid substance or stable iodine may persist for weeks. 16 references.

278 The zone of activity of antibodies as determined by the use of radioactive tracers. David Pressman. Trans. New York Acad. Sci. 2, 203-6(1949) Apr.

The preparation of a rat anti-kidney serum and the results obtained by tracing its course through the use of incorporated radioactive iodine are described. Iodine-131 was used as the tracer element and was introduced into a test serum in order to test the validity of the procedure by the following experiment: anti-ovalbumin serum was iodinated with $I^{131}$ and mixed with antiserum prepared against beef serum coupled with diazotized para-aminobenzoic acid; the resulting mixture was precipitated with ovalbumin and tested and confirmed for antibody specificity and for radioactivity. The preparation of the anti-kidney serum was fractionated to remove the globulin which was then iodinated by concentrations of $I^{131}$. This iodinated globulin anti-kidney serum was the material used to trace the antibody's specificity within the body. The results indicate that the radioantibody concentrates in a small punctate region of the kidney, which corresponds to the glomerulus. 19 references.

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279 Detection of lead in air with the aid of a Geiger-Müller counter. O. G. Koppius. J. Optical Soc. Am. 39, 294-7(1949) Apr.

A detector of lead in air is described which utilizes a spark source for the excitation of the lead spectrum, a small quartz spectrometer for the dispersion, and a quartz Geiger-Müller counter for the detector of the radiation. The lower limit of detection is of the order 20 $\mu$g of lead per cubic foot of air. The instrument is mobile and suitable for the location of areas of high lead concentration in air.

280 A rapid mobile analyzer for minute amounts of lead in air. Henry Aughey. J. Optical Soc. Am. 39, 292-3(1949) Apr.

A mobile instrument of extreme sensitivity has been developed which furnishes a rapid indication and an approximate assay of localized relatively high concentrations of lead, combined or elemental. Samples are drawn through a condensed spark discharge adjusted to minimize air lines and to excite the lead spectrum which is photographed with a small quartz instrument. Visual examination of a series of exposures provides data on lead concentration as a function of time and location. A sensitivity of better than 1 part in 20 million can be maintained in routine operation. Instantaneous response has been realized by substitution of the photoelectric Geiger counter for the photographic plate.

281 An improved apparatus and procedure for ascending paper chromatography on large size filter paper sheets. W. Q. Woflson, C. Cohn, and W. A. Devaney. Science 109, 541-3 (1949) May 27.

The improved apparatus described makes possible consistently good two-dimensional chromatograms by the ascending technique on 18-in. by 22-in. Whatman No. 1 filter paper sheets or on 23-in. by 23-in. S and S No. 604 filter paper sheets. The chromatography tank itself is a 20-gal 26-lb stainless steel tank provided with two carrying handles and having an inside height of 24 in. and inside diameter of 16 in. The construction is fully described. A comparison is made with the older types of tanks and their disadvantages are pointed out. The procedure used follows that of Williams and Kirby with few exceptions. Features of the tank design which permit operation at reduced pressures were introduced because of findings during preliminary attempts to fractionate protein mixtures and diazotized protein mixtures. In the procedure mentioned, the developing solvent is a salt solution which has a salt concentration approaching that at which the protein component of minimum solubility will precipitate.

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282 A method for the determination of organic compounds in the form of isotopic derivatives. I. Estimation of amino acids by the carrier technique. Albert S. Keston, Sidney Udenfriend, and R. Keith Cannan. J. Am. Chem. Soc. 71, 249-57(1949) Jan.

A new principle for the application of isotopes to the determination of organic compounds is introduced and its application to the determination of amino acids is presented. A mixture is treated with an isotopic reagent to form quantitatively an isotopic derivative of the desired amino acid. A large excess (W moles) of the unlabelled derivative is added as carrier and purified to constant isotope concentration Cc. Knowing the specific radioactivity of the purified carrier and of a suitably prepared standard and also the fraction of carrier remaining after purification, one can calculate the quantity of amino acid present in the original mixture. If Cr be the molal isotope concentration of a pure isotopic derivative which has been prepared with the same sample of the reagent, then the amount of the isotopic derivative (w) which was present in the mixture is

$$w = Cc(w + W)/Cr.$$

When relatively large amounts of the carrier are added, this equation reduces to

$$w = WCc/Cr.$$

As reagent, p-iodophenyl sulfonyl chloride (pipsyl chloride) containing $I^{131}$ was used. The method has extremely high sensitivity, being operable below the microgram level, and has the inherent specificity and accuracy characteristic of isotope techniques. Recoveries of added amounts of glycine, alanine and proline from a mixture of 12 synthetic amino acids are reported to demonstrate the accuracy and specificity of the analytical procedure. Values are reported for the glycine, alanine and proline contents of the crystalline proteings $\beta$-lactoglobulin, human hemoglobin, aldolase and phosphoglyceraldehyde dehydrogenase.

283 Spectrophotometric studies of dilute aqueous periodate solutions. Carl E. Crouthamel, Homer V. Meek, D. S. Martin, and Charles V. Banks. AECU-237, 1949. 16p.

It was shown that most probably any equilibria involving the formation of the dimesoperiodate ion, $I_2O_9^{-4}$, is of no importance in dilute aqueous solutions. Three simple equilibria involving stepwise dissociation of metaperiodic acid, $H_5IO_6$, account completely for the variation of the ultraviolet absorption spectra of dilute aqueous solutions of periodate with pH. $K_1$ (Rothmund and Drucker, Z. Physik. Chem. 46, 850(1903); Rae, J. Chem. Soc. 876(1931)) was substantiated and new estimates of $K_2$ and $K_3$ were made from spectrophotometric studies. $K_2$ was substantially confirmed by potentiometric studies and $K_3$ was confirmed by the method of Hill (J. Am. Chem. Soc. 65, 1564(1943)). Evidence was shown for abnormal activity coefficients of $H_4IO_6^-$ and $H_3IO_6^=$ ions with increasing ionic strength. Recommendations were made for the spectrophotometric determination of periodate in slightly acid and alkaline solutions. The values assigned the three dissociation constants for periodic acid are given as: $K_1 = 2.3 \times 10^{-2}$; $K_2 = 4.35 \times 10^{-9}$; and $K_3 = 1.05 \times 10^{-15}$.

284 The application of the halogen-metal interconversion reaction to syntheses with isotopic carbon. Arthur Murray, III, W. W. Foreman, and Wright Langham. Isotopes Branch Circular IDC-7 (Los Alamos Scientific Laboratory) Aug., 1947. 9p.

The halogen-metal interconversion reaction between the appropriate aryl halide and n-butyllithium has been applied on a 1-mmol scale to the preparation of p-aminobenzoic and nicotinic acids marked in the carboxyl groups with $C^{14}$. These biologically important compounds have been prepared with extremely high specific activities. Nicotinic acid containing 0.9 isotopic % of $C^{13}$ has also been prepared by the same procedure.

285 Can we account for the observed abundances of the chemical elements? D. ter Haar. Am. J. Phys. 17, 282-7(1949) May.

The present state of the theories which attempt to explain the observed abundances of the elements is considered. The various theories are reviewed and discussed (following their historical order of development for the most part) under the following subjects: (1) excited nuclear states; (2) electrostatic effects; (3) gravitational effects; (4) transition to normal temperatures and densities; (5) transition to stable nuclei; (6) places in the universe in which nuclei could be formed; (7) a consideration of (6) in terms of theories of general cosmogony; and (8) the $\alpha$-$\beta$-$\gamma$ theory. 24 references.

CHEMISTRY (continued)

286 Information on synthesis with $C^{14}$ acetic acid from $CO_2$. Isotopes Branch Circular IDC-2 Jan. 10, 1947. 16p.

The following steps in the synthesis of acetic acid from radioactive carbon dioxide are reported in detail: preparation and carbonation of Grignard reagent, distillation of dilute acetic acid, evaporation to sodium acetate, acidification of sodium acetate and distillation, and ether extraction and final distillation, of acetic acid. Experiments on the preparation of acetyl chloride are attached in an appendix.

287 Laboratory production of enriched $BF_3$ from $CaF_2BF_3$. R. E. Zedler and R. I. Luman. Isotopes Division Circular IDC-6 (Clinton Laboratories) July, 1947. 5p.

Boron trifluoride ($BF_3$) is the gas commonly used in slow-neutron counters. As furnished by the AEC Isotopes Division, the boron in the complex $CaF_2 \cdot BF_3$ is 96% $B^{10}$ as compared with the normally occurring $B^{10}$ content of 20%. Since counter-action results only on the slow neutron capture by $B^{10}$, counters five times as efficient may be obtained by filling them with enriched $BF_3$ generated from this complex. The boron trifluoride gas is generated by heating the complex and collecting the gas in a closed evacuated system: $CaF_2 \cdot BF_3 \rightarrow CaF_2 + BF_3$·6.5 grams of the complex produce 1 liter (3g) of $BF_3$ at S.C.T.P. The equipment is described in succession from generator to receiving flasks.

288 Radioactive testosterone containing $C^{14}$ in ring A. Richard B. Turner. Isotopes Branch Circular IDC-5 (Harvard University) July, 1947. 5p.

A procedure for the preparation of 3-radiotestosterone, with an activity of $1.45 \times 10^4$ counts/min/mmol, from phenylacetate with an activity of $1.76 \times 10^4$ counts/min/mmol is detailed.

289 Some recent advances in radiochemistry. H. J. Emeléus. Nature 163, 624-7(1949) Apr. 23.

Three primary fields in which major advances in radiochemistry have been recently made are treated briefly. First, the chemical separation of the fission products of uranium and other fissile elements is described. The problems involved in this field are largely those of ordinary chemical analysis, differing mainly in complexity and in the fact that microchemical techniques are used. Secondly, the problem of fitting the many new radioactive isotopes of the heavy elements into modifications of classical decay series is discussed, and the combined methods of physics and chemistry which have proved of value in this respect are outlined. Chemically, the new elements neptunium, plutonium, americium, and curium are believed to form part of a new series, the actinides; the arrangement of the extra-nuclear electrons of elements of the series is analogous to the rare earths (the lanthanides). The third major problem considered is that of the chemistry of the new transuranic elements as well as of francium (Z = 87), astatine (Z = 85), prometheum (Z = 61), and technetium (Z = 43). Tabulated results of x-ray studies comparing the ion size contraction observed as the thoride, actinide, and lanthanide series are ascended are discussed, and the valencies of the lanthanides and actinides are compared.

290 Capture of hydrogen atoms by $C_2$-hydrocarbons. W. Mund, R. Lories, and P. Huyskens. Bull. soc. chim. Belges 57, 490-2(1948) Nov.-Dec. (in French).

This is part of a study on the inhibitory influence of the presence of various substances on the reaction $H_2 + D_2 = 2HD$. In Bull. acad. roy. Belg. 54, 651(1948) the action of $CH_4$ and $C_6H_6$ has been studied. In the present paper data are given concerning the action of $C_2H_2$, $C_2H_4$, and $C_2H_6$. It has been found that the inhibitive influence of $C_2H_4$ and of $C_2H_6$ is twice as large as that of $CH_4$ and of $C_6H_6$. The influence of $C_2H_2$ is slightly inferior to that of the last two mentioned hydrocarbons.

291 Density of heavy water. Tsing-Lien Chang and Lü-Ho Tung. Nature 163, 737(1949) May 7.

Experiments measuring the density of deuterium oxide at temperatures up to 100°C are described. A 16-ml quartz pycnometer was used in connection with a thermostat. Special precautions were taken regarding the pycnometry, the thermometry, the purification of the water, the avoidance of contact with atmospheric moisture, the reduction of the weighings to vacuum, and the volume correction for the thermal expansion of vitreous quartz. The procedures, the calculations, and a table listing the temperature-density data from 3.8°C to 101.4°C are included.

CHEMISTRY (continued)

292 Interception of hydrogen atoms by $NH_3$, $N_2H_4$, $H_2S$, and $H_2O$. W. Mund, R. Lories, and P. Huyskens. Bull. soc. chim. Belges 57, 469-89 (1948) Nov.-Dec. (in French).

In a mixture of hydrogen and deuterium, acted upon by x-rays, the reaction $H_2 + D_2 = 2HD$ takes places, which is known to be inhibited by the presence of small quantities of other gases. In the present work, the influence of the presence of $NH_3$, $N_2H_4$, $H_2S$, and $H_2O$ has been studied. The inhibiting influence of these substances is interpreted as an interruption of the main reaction by a reaction between hydrogen and one or the other of the substances studied. In the bibliography 18 works are listed, most of them Belgian.

293 Mass spectrum of hydrogen deuteride (HD). R. A. Friedel and A. G. Sharkey, Jr. J. Chem. Phys. 17, 584-5(1949) June (Letter to the editor).

The relative abundance of D+ from HD cannot be determined directly because of the interference of unknown $H_2$ impurity. However, this difficulty was avoided by measuring the rates of diffusion through the leak system of the mass spectrometer. Relative rates for $H_2$, measured at mass 2, and for HD, measured at mass 3, were found to be 12.72 and 10.46 % / min, respectively. The percentages of $H_2$ impurity and the relative abundance of D+, $1.13 \pm 0.05$, were determined. The relative abundances of all ions from HD, $H_2$ (100%), and $D_2$ (99.2% $D_2$, 0.8% HD) are given in tabular form. Equilibrium constants at 500°C for $H_2 + D_2 \rightleftharpoons 2HD$ have been calculated from these data. The values obtained are in good agreement with the theoretical values.

294 Preparation of high-purity hydrogen deuteride from lithium aluminum hydride. Irving Wender, R. A. Friedel, and Milton Orchin. J. Am. Chem. Soc. 71, 1140(1949) Mar. (Communication to the editor).

Hydrogen deuteride can be prepared by the action of certain metallic hydrides, such as sodium hydride or lithium aluminum hydride, upon heavy water. Since the heat evolved in the reaction promotes the formation of $D_2$ and $H_2$, the preparation should be carried out in a cold bath. Thus, the reaction with lithium aluminum hydride, in a bath at 0°, resulted in a formation of 99% pure HD.

295 Viscosity of deuterium oxide and water from 5° to 125°C. R. C. Hardy and R. L. Cottington. J. Chem Phys. 17, 509-10(1949) May (Letter to the editor).

Accurate data have been obtained on the viscosity of deuterium oxide and water in the temperature range 5° to 125°C. The readings in the range 5°-95°C were made with a Bingham variable pressure viscometer calibrated with water at 20°C; an Ostwald-type viscometer of special design was used for measurements in the 90-125°C range. Tabulated values of the absolute viscosity of deuterium oxide and of water (estimated to be accurate to within 0.1%) and of the density of deuterium oxide in the 90-125°C range are given.

296 Physical properties of chlorotrifluoroethylene polymers. V. The vapor pressure of chlorotrifluoroethylene polymers as a function of temperature and number average molecular weight. J. L. Gabbard, J. H. Jamieson, and J. W. Grisard. AECU-241, May 20, 1949. 15p.

The vapor pressure of several fractions of chlorotrifluoroethylene polymers has been determined as a function of temperature, using a pendulum tensimeter. Empirical equations of the form $\log P = A - B/T$ were derived showing the relationship between vapor pressure and temperature, and the heats of vaporization were calculated. The relationship between the average molecular weight of the polymers and vapor pressure at 60°C is presented graphically.

297 Investigation of the hydrolysis of halogenated hydrocarbon compounds. Kenneth L. Temple and John K. Wolfe. Naval Research Laboratory Report NRL-C-3284, May 13, 1948. 13p.

The hydrolytic stability has been determined for a variety of chlorinated and fluorinated organic liquids prepared for or submitted to this laboratory during World War II. A comparison is made with the results of Brockway and Livingston ("Electron diffraction investigation of fluorocarbons. Univ. of Mich. Dept. of Engr. Res. Project No. M-510, June 30, 1944) on the bonding distances in halogenated compounds. The corrosiveness of the acids obtained from the hydrolysis of minute amounts of chlorinated and fluorinated organic compounds necessitated the use of extremely stable materials or efficiently inhibited fluids.

CHEMISTRY (continued)

298 A laminar form of the periodic table. A. N. Wrigley, W. C. Mast, and T. P. McCurcheon. J. Chem. Education 26, 216-8, 248-50(1949) Apr.-May.

A table of chemical elements is described exhibiting the relations among the atomic number of each element, its electronic configuration, and its position in the periodic system. This end is achieved by inscribing the table on a sequence of seven laminated cards, so that a three-dimensional effect is obtained. The electronic configuration of an element is read off card by card. The arrangement permits the reader to recognize abnormal configurations, together with the fact that the irregularities involve electrons of the d subshells. Two different designs of the chart are presented. As a modification, the construction of a contour laminar table is suggested, which represents actual energy levels without the necessity of referring to auxiliary tables.

299 The effect of electric fields on the decomposition of nitrous oxide by alpha-rays. Nelson T. Williams and Harry Essex. J. Chem. Phys. 16, 1153-7(1948) Dec.

Experiments were made which indicate that the combination of oppositely charged ions plays no part in initiating the decomposition of nitrous oxide by $\alpha$-rays at 10-cm and at 20-cm pressure. The decomposition in the absence of a field is evidently largely initiated by the splitting of molecules on electron collision. The application of electric fields above those required to attain half-saturation increases the ion yield because of the acceleration of free electrons by the fields. At higher field strengths the ion yield attains a value which remains unchanged on further increase in field strength. When the ion yield has this final constant value all electrons are attached to form negative atomic or molecular ions before reaching the electrode. Assuming the same reactions occur on electron collision as in the photochemical reaction the increase in ion yield as a result of the effect of the field involves a minimum of 1.2 molecules of nitrous oxide split without attachment of the electron for each molecule split with attachment.

300 The separation of rare earths by ion exchange. IV. Further investigations concerning variables involved in the separation of samarium, neodymium and praseodymium. F. H. Spedding, E. I. Fulmer, T. A. Butler, and J. E. Powell. AECU-235, Mar. 1949. 27p.

This paper describes some experiments designed to contribute fundamental data concerning the separation of the rare earth pairs, Sm, Nd and Nd, Pr using Amberlite IR-100 resin and 0.5% citric acid ammonium citrate solutions as the eluant. Such variables as temperature, pH of eluant, size of resin particles, and flow rate were studied. The rapid change in the shape of the elution curves of pure Sm and Nd with small variations in the pH values of the eluant was shown. Variations in temperature of the eluting solution over the range 0°C to 50°C caused the shape of the elution curves to change. Lowering the temperature of the solution had an effect comparable to increasing the pH of the eluant, whereas, raising the temperature of the solution gave the opposite effect. At the higher temperature it appeared that the equilibrium between the rare earth citrate complex and the resin was more nearly attained. Reducing the particle size of the resin had the effect of allowing equilibrium conditions in the column to be approached. In general, increasing the flow rate by a factor of four caused the rare earth breakdown to be delayed, the elution curves to spread out somewhat, and the peak concentration of rare earths to be lower.

301 The separation of rare earths by ion exchange. V. Investigations with one-tenth per cent citric acid-ammonium citrate solutions. F. H. Spedding, E. I. Fulmer, J. E. Powell, and F. A. Butler, AECU-249, Mar., 1949, 34p.

A number of variables involved in the separation of rare earths with 0.1% citric acid-ammonium citrate solution and Amberlite IR-100 resin beds have been investigated. It was found that the separation decreased as the pH of the eluant increased. The decrease was due primarily to the higher concentration of rare earths in the volume of eluate associated with the overlap between consecutive rare earth bands rather than to an increase of the overlap volume itself. Flow rate and particle size were found to be primary factors in the amount of band overlap observed. These variables are closely associated with the degree of equilibrium maintained between the solution in the pores of the resin

and the solution flowing over the surface of the resin particles. The separation was independent of column length provided that the column was longer than the minimum length required for development of a given sample weight. That is, there was no decrease in the overlap between consecutive bands as one increased the length beyond this minimum requirement. It was predicted from column length experiments and later proved conclusively that the efficiency of separation could be improved considerably by increasing column load and column length in a direct ratio. However, when the column load was increased beyond a certain point a precipitate formed in the resin bed. It was determined that the proper load of equimolar $Sm_2O_3$-$Nd_2O_3$ mixture for an Amberlite IR-100 bed, 22 mm in diameter and eluted with 0.1% citrate solution at pH of 6.00 was 1.5 g/30 cm of bed height. At a flow rate of 0.25 cm/min one should not exceed a sample size of 4.75 g on a bed 22 mm in diameter. This would fix the column length at 95 cm.

302 Analysis of rare earth oxides by means of emission spectra. Part I. Persistent lines in arc spectra of rare earth elements. D. M. Smith and G. N. Wiggins. Analyst 74, 95-101(1949) Feb.

The analysis of rare earth oxides by means of their arc emission spectra presents a number of difficulties on account of the great complexity of these spectra. This is particularly evident when an examination is made for other rare elements occurring as impurities. In the present work a determination was made (1) of the most persistent lines of rare earth elements for a given type of arc excitation, and (2) of faint lines coinciding with impurity lines. Data on the most persistent lines of 15 elements are assembled in a table, viz. wavelengths, intensities (for arc and spark excitations), and sensitivities (a-c and d-c). In other tables information is given on certain faint lines in the spectra of rare elements which are due to other rare earth elements present as impurities.

303 Analysis of rare earth oxides by means of emission spectra. Part II. A technique for the suppression of cyanogen bands in carbon arc spectra of rare earth oxides. G. N. Wiggins. Analyst 74, 101-4(1949) Feb.

In the course of the work on empirical determination of the most persistent lines of the rare earth elements, reported in Part I of this paper, (Smith and Wiggins, Analyst 74, 95-101(1949)), it was concluded that the arc (either a-c or d-c) between pure silver electrodes was less sensitive in detecting impurities than that between pure carbon or graphite electrodes. Since the "cyanogen" bands (the violet system due to the diatomic molecule CN) appear strongly in the region 2960 to 6000 A, where most of the sensitive lines of the rare earth elements occur, various attempts were made to suppress the emission of these bands by running the arc in a nitrogen-free atmosphere. The simplest atmosphere to produce was water vapor, and a simple steam chamber to surround the electrodes was constructed. It consisted of a small aluminum can with a removable lid and holes to admit the electrode and to provide the steam inlet; a quartz window, used at first, was recognized as superfluous, as the steam expelled the air from the chamber completely. The steam was produced from a flask of boiling water. Photographs illustrate the effective suppression of the cyanogen bands in the spectra of rare earth oxides.

304 The magnetic susceptibilities of the rare-earth elements. Part I. Yttrium. O. M. M. Hilal and S. Sugden. J. Chem. Soc., 135-6(1949) Jan.

Yttrium has been purified by fractional precipitation by ammonia carried in a current of air and the process followed by magnetic susceptibility measurements. The limiting value found for $10^6\chi^{20^\circ}_{Y}$... is 0.21 ± 0.02.

305 The magnetic susceptibilities of the rare-earth elements. Part II. Samarium. S. Sugden and S. R. Tailby. J. Chem. Soc., 136-7(1949) Jan.

Samarium has been purified by fractional crystallization of the double magnesium nitrate in the presence of bismuth magnesium nitrate, and the process has been followed by magnetic susceptibility measurements. The value found for $10^6\chi^{20}_{Sm}$ ... is 6.72 ± 0.03.

CHEMISTRY (continued)

306 The magnetic susceptibilities of the rare-earth elements. Part III. Gadolinium. S. Sugden and S. R. Tailby. J. Chem. Soc., 137-8(1949) Jan.

Gadolinium has been purified by fractional crystallization of the double magnesium nitrate in the presence of bismuth magnesium nitrate, and the process has been followed by magnetic susceptibility measurements. The value found for $10^6\chi^{20^\circ}_{Gd}$ . . . is 168.4 ± 0.2.

307 The magnetic susceptibilities of the rare-earth elements. Part IV. Thulium. S. Sugden and S. R. Tailby. J. Chem. Soc., 139-40(1949) Jan.

Thulium has been isolated by prolonged fractional crystallization of the bromate followed by treatment with sodium amalgam to remove ytterbium. The value found for $10^6\chi^{20^\circ}_{Tm}$ . . . is 136.5.

308 On the fixation of hydrogen and of deuterium by lanthanum and cerium. Rodolphe Viallard and Pauline Jaszczyn. Compt. Rend. 228, 485-7(1949) Feb. 7 (in French).

A study of hydrogen and deuterium in chemical combination with the rare earths using apparatus of a type previously described (R. Viallard, Ann. Chim. (Paris), 1-70(1945)) has indicated that lanthanum can be used to fix deuterium to give the compound $LaD_3$. Other investigators have similarly deduced the existence of the corresponding hydrogen compound (W. Muthmann and K. Kraft, Ann. Chem. 325, 261(1902)). In addition new experiments have confirmed the fact that deuterium and cerium combine as $CeD_3$ more often than as $CeD_2$. The results obtained are presented in tabular form. Using lanthanum $\beta$ in various states, the values obtained for the number of atoms of deuterium fixed per atom of the metal ranged from 2.91 to 3.10; for cerium $\beta$ the values determined ranged from 2.21 to 2.75.

309 The spectra of the hydrogen molecules containing tritium. Progress report for the period October 15, 1948 - March 31, 1949. G. H. Dieke. AECU-236, nd. 12p.

The chief purpose of the work was the detailed study of the structure of the hydrogen molecule as revealed by its spectrum. With the availability of deuterium and tritium besides ordinary hydrogen there are now six isotopic species, $H_2$, DH, $D_2$, TH, TD, and $T_2$ that can be studied. The last three form the immediate object of study of the project. A general plan of the work, which was divided between the Argonne National Laboratory and Johns Hopkins University, is outlined. Results are reported on measurement of plates of the region from 3300 to 8800 A and the Fulcher bands of TH and $T_2$. Wavelength measurements, photography of the spectrum, analysis of band systems, intensity measurements and variability of the spectra, and electrodeless discharges are discussed.

310 Microwave methods in physics. I. Microwave spectroscopy. C. Kikuchi and R. D. Spence. Am. J. Phys. 17, 288-300(1949) May.

The applications of microwave spectroscopy in physics are considered. In particular, the use of these methods to obtain more precise values for certain molecular, atomic, and nuclear constants is reviewed. A few of the pertinent mathematical expressions are derived, and the experimental equipment used in such measurements is described. Tabulated data, obtained from microwave spectroscopy, are given on the molecular and nuclear structure of 36 isotopic variations of 11 compounds. Values are given for specified J transitions for the quadrupole coupling constant, internuclear distance, and the moments of inertia of the molecule about two different axes. A second table lists the nuclear constants for the following nuclei: $As^{75}$, $S^{32}$, $S^{33}$, $S^{34}$, $O^{18}$, $Cl^{35}$, $Cl^{37}$, $Br^{79}$, $Br^{81}$, $N^{14}$, $I^{127}$, and $B^{10}$. The data, which were compiled from various sources, include values for the spin, quadrupole coupling, and quadrupole moment. 13 references.

CHEMISTRY (continued)

311 The optical detection of radio-frequency resonance. F. Bitter. MIT Research Laboratory of Electronics Technical Report No. 98, Mar. 2, 1949. 5p. (NP-839).

Calculations are made of the frequency, intensity, and polarization of the light emitted by an atom in a doublet P to a doublet S transition in a weak magnetic field having an oscillating component. Near resonance, or when the frequency of the oscillating component approaches the Larmor frequency of one of the two states involved in the radiation process, all of the quantities calculated are modified. Qualitatively similar results are to be expected for other transitions. Observations in very weak fields would be of particular interest because they would give information on nuclear as well as atomic g-factors. Under such conditions, the Zeemann components will in general not be resolvable, and the only observable effect will be a change in the polarization of the edges of a spectral line at resonance. It is further shown that very small changes in this polarization structure are theoretically detectable.

312 Degradation of glucose-1-$C^{14}$ and a possible new step in the mechanism of fermentation. S. Aronoff, V. A. Hass, and B. Fries. AECU-234, Apr. 1949, 7p.

Using glucose-1-$C^{14}$ a previously proposed scheme of glucose degradation applied to sugars formed in photosynthesis has been verified (Aronoff, et. al, J. Biol. Chem. 169, 459(1947)). The degradation procedure involves the following sequence of reactions: fermentation of glucose to lactic acid with Lactobacillus casei $\epsilon$; oxidation of lactic acid to $CO_2$ (carbons three and four of original glucose) and acetic acid; the pyrolysis of barium acetate to acetone and $BaCO_3$ (carbons two and five); and the formation of iodoform (carbons one and six) from the acetone. There appears to be another, though minor, pathway of fermentation of glucose to lactic acid by the test organism other than the oxidation of carbons three and four of the glucose.

313 The exchange reaction between the two oxidation states of cerium in nitric acid solutions. J. W. Gryder and R. W. Dodson. J. Am. Chem. Soc. 71, 1894-5(1949) May (Communication to the editor).

The exchange reaction between cerous and ceric ions in nitric acid solutions was studied, using $Ce^{144}$ (275-day half-life). The method employed consisted in extracting ceric cerium from the solution with diethyl ether. The results obtained with solutions 6.18 f in nitric acid are given in a table. The expected exponential time dependence of the extent of exchange was confirmed. The experimental energy of activation was found to be $13.4 \pm 0.7$ kcal. It was concluded that the reaction is first order with respect to both cerous and ceric concentrations.

314 Hydrogen-deuterium exchange in mixtures of methane, hydrogen and oxygen. J. Wijnen and A. Van Tiggelen. Bull. soc. chim. belges 57, 446-66(1948) Nov-Dec. (in French).

Slow combustion of methane was studied by using D as an indicator. The reaction took place at 500°C in mixtures of methane, oxygen, and hydrogen containing 50 or 58% of D. It was found that the exchange hydrogen-deuterium requires the presence of oxygen and reaches a maximum at a certain oxygen concentration; the activation energy of the exchange equals the activation energy of the methane combustion (87,000 cal $\pm$ 10%). The results of the investigation confirmed the authors' views on the mechanism of the slow combustion of methane, consisting in a succession of reactions of which the starting one is $CH_4 = CH_2 + H_2$.

315 The isomerization of n-butane-1-$C^{13}$. J. W. Otvos, D. P. Stevenson, C. D. Wagner, and O. Beeck. J. Chem. Phys. 16, 745(1948) July (Letter to the editor).

An investigation has been made of the reactions of n-butane-1-$C^{13}$ in the presence of a water promoted aluminum bromide catalyst at about 25°C. The general methods which were previously outlines were used (J. Chem. Phys 16, 255(1948)). The mass spectrometric analyses were supplemented, as needed, by low temperature distillation through a high efficiency Podbielniak column and infrared spectrophotometric analyses. Tabulated data on the resulting isomerization are given which indicate that

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n-butane-2-$C^{13}$, i-butane-1-$C^{13}$, and i-butane-2-$C^{13}$ were formed from the n-butane-1-$C^{13}$ in the ratios 2:3:1, respectively. These relative rates of formation of the three isomers of n-butane-1-$C^{13}$ are in the ratio of their random statistical weights and are most easily explained in terms of a single activated complex which may rearrange at random into the four butane-$C^{13}$ isomers. The experiments point toward a general activation of the molecule as a whole.

316 The structure of neoprene II. Determination of end-groups by means of radiosulfur. W. E. Mochel and J. H. Peterson. J. Am. Chem. Soc. 71, 1426-32(1949) Apr.

Neoprene Type GN is essentially a copolymer of chloroprene and sulfur in the approximate ratio of 100 chloroprene units per sulfur atom. This was determined by the use of radioactive sulfur. The sulfur units are cleaved by an alkaline emulsion of tetraethyl thiuram disulfide so that a gel polymer containing combined sulfur can thus be converted to a soluble, plastic product. Potassium persulfate, used as initiator for the polymerization of neoprene, appears to be combined with the polymer in Neoprene Type GN in amounts equivalent to 8-17 polymer molecules formed for each sulfur-containing initiator fragment. When dodecyl mercaptan is used as modifier, a large proportion of the polymer molecules contain essentially no combined sulfur from the persulfate, and it appears that the true initiator is the RS free radical formed by reaction of the mercaptan with potassium persulfate. High molecular weight fractions contained 3-4 mercaptan sulfur atoms per polymer molecule, and the results suggest that mercaptan addition to the double bonds of the polymer had occurred.

ENGINEERING

317 The first isolation of plutonium. B. B. Cunningham and L. B. Werner. J. Am. Chem. Soc. 71, 1521-8(1949) May.

The isolation of chemically pure plutonium and the preparation of the first pure compounds of this element are described. Methods are described for the preparation and purification of plutonium compounds on a 1-30 $\mu$g scale. The specific $\alpha$-activity of $Pu^{239}$ was determined by weighing microgram samples of plutonium oxide and the value $7.1 \pm 0.1 \times 10^4$ $\alpha$-counts/min/$\mu$g (in a $2\pi$ geometry counter) found. The half-life of the isotope $Pu^{239}$ has been computed from specific activity and counting yield measurements to be 24,300 $\pm$ 370 yr. It is shown that the +4 state is a stable oxidation state of plutonium. Approximate solubilities of plutonium iodate, ammonium plutonium fluoride, plutonium "hydroxide", and plutonium peroxide have been determined. The colors of these compounds and of plutonium oxide have been noted. Five figures show the instruments used for chemical operations on the microgram scale.

318 Mechanism of the disproportionation of plutonium(V). Robert E. Connick J. Am. Chem. Soc. 71, 1528-33(1949) May.

The disproportionation of plutonium(V) into plutonium(VI) and plutonium(IV) or plutonium(III) is expected to proceed by either of two possible mechanisms. From a study of the rate of the disproportionation in 0.5M hydrochloric acid, it is shown that the actual mechanism consists of the slow neutron

$$Pu(V) + Pu(III) \rightarrow 2Pu(IV)$$

coupled with the rapid equilibrium

$$Pu(V) + Pu(IV) = Pu(III) + Pu(VI)$$

A possible explanation of the faster reaction through this mechanism compared to that of the other possible mechanism is given. The mechanism of disproportionation of plutonium(V) is essentially the reverse of that for the disproportionation of plutonium(IV). The rate constant for this latter reaction is calculated and compared with experimental data. The importance of the mechanism of disproportionation of plutonium(V) in the reduction of plutonium(VI) is discussed.

ENGINEERING (continued)

319 A Method for separation of uranium from phosphoric acid. Application for the Recovery of Uranium. M. A. Morette. Ann. Pharm. Franc. 6, 529-34(1948) Nov.-Dec. (in French).

A method is shown for the separation of uranium from the phosphate ion, which can be used in analysis and as a means for recovering uranium from the waste product from biochemical laboratories where the dosage of phosphates is made by titration with uranyl salts. The originality of the procedure lies in the use of calcium hydroxide for the disintegration of uranyl phosphate. The method consists of the following operations: uranyl phosphate is mixed, in water, with slaked lime; the product of the reaction is an insoluble mixture of red calcium uranate and calcium phosphate. Through the addition of ammonium carbonate a soluble uranocarbonate complex is formed, from which, after filtration and neutralization with $HNO_3$, uranate of ammonia is precipitated by adding $NH_3$; this is transformed into a solution of uranyl nitrate.

320 Preliminary note on the presence of uranium in living things in Argentina. Siegfried G. Lexow, Ernesto P. P. Maneschi, and Adolfo M. Sa. Anales asoc. quim. argentina 36, 203-7(1948).

An analysis of the uranium content of various plants and animals of Argentina has been made. Human bones, in particular the cranium, and cattle bones were found to contain this metal, and an unusually high concentration of uranium was found in the ash of Larrea divaricata, a precordilleran shrub and xerophyte from Papgayos. Plants were found which contained appreciable amounts of uranium although growing in soils where uranium is present only in infinitesimal quantities. Although uranium was found in the ash of white quebracho (Aspidosperma quebracho) and colored quebracho (Schinopsis lorentzii) it was not found in yerba maté. It is also noted that an intense uranium reaction was obtained for a marine alga of the genus Codium.

321 Proceedings of the thirty-third annual meeting of the optical society of America. J. Optical Soc. Am. 38, 1092-1107(1948) Dec.

The thirty-third annual meeting of the Optical Society of America was held in Detroit, Michigan, on October 21, 22, and 23, 1948. Abstracts of the papers given include: A Spectrochemical Method for the Determination of Uranium, by L. T. Steadman; A Preliminary Investigation of the Spectra of Uranium Isotopes, by J. Rand McNally, Jr.; A Rapid Mobile Analyzer for Minute Amounts of Lead in Air, by Henry Aughey; Detection of Lead in Air with the Aid of a Geiger-Müller Counter, by O. G. Koppius.

322 Report upon the nuclear spin of weak U metal isotope. S. Tolansky. BR-392, nd. 5p.

It has been found that the U metal spectrum can be excited with very great intensity in a suitably controlled hollow cathode discharge. An extensive rich lined spectrum is given out. Observation has so far been restricted to the visible. The following was ascertained. The hyperfine structure observed in the strong unclassified line 5027 is attributed to the weak odd isotope $U^{235}$. The estimated abundance ratio is less than 1 in 95. It is probable that this ratio is underestimated by up to 50%. Hence, the abundance is probably between 1 in 95 and 1 in 140. The spin exceeds 1/2 and the value 3/2 is excluded. From the estimated intensities of an admittedly partially resolved hyperfine structure pattern the spin appears to be $> 5/2$. The size of the structure indicates a moderately large magnetic moment of the nucleus of approximately average value. The above conclusions as to spin are tentative and based upon little material.

323 A source of error in the colorimetric estimation of uranium. T. R. Scott. Nature 163, 768-9(1949) May 14.

It has been found that the error occurring when the hydrogen peroxide method (Colorimetric determination of traces of metals. (E. B. Sandell, Interscience Publishers, Inc., New York (1944)) for the estimation of uranium content is applied using a modern type of spectrophotometer (the colors

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being measured at 360 mμ) can be traced to the presence of sodium bicarbonate. The results, which were previously found to be low by as much as 30%, can be best corrected by avoiding the formation of bicarbonate. This can be done by neutralizing the acid solutions containing uranium with sodium hydroxide; the neutral solutions are then treated with sodium carbonate and the color developed as usual with hydrogen peroxide.

324 Spectrophotometric studies of complex formation with sulfosalicylic acid. II. With uranyl ion. Robert T. Foley and Robbin C. Anderson. J. Am. Chem. Soc. 71, 909-12(1949) Mar.

As part of a series of studies on complex formation with sulfosalicylic acid, it has been of interest to compare the reactions of uranium—as a member of another transition series of elements—with that of iron. Weil and Rozenblum (Bull. tran. inst. pharm. (Poland) I, 1(1902)) reported a solid compound of uranium and sulfosalicylate, $(C_6H_3(OH)(SO_3)(COO))_2U$, but no observations in solution were made. Muller, Fernandes, Mai and Weinland and Hager (Z. anorg. u allgem. Chem. 160, 193 (1927)) have reported complex formation between uranyl ion and salicylic acid or various salts. In this particular investigation reactions of sulfosalicylic acid in solutions containing uranium as uranyl ion have been studied. Spectrophotometric data for solutions with concentrations in the region of 0.005M and over a pH range of 2-10 indicate only one complex formed with uranyl ion and sulfosalicylic acid. This involves a 1:1 mole ratio of uranyl and sulfosalicylic acid. The effects of changing pH, of temperature, and of acetate ion have been studied. The dissociation constant and free energy of formation of the complex have been calculated.

325 Thermogravimetric analysis of precipitates. XXIV. Dosage of uranium. Clément Duval. Analyt. Chim. Acta 3, 335-44(1949) May (in French).

A study has been made of the gravimetric methods for the determination of 4- and 6-valent uranium; two new forms of weighing are suggested, as oxalate and anhydrous oxinate. The following table summarizes the temperature limits, determined by means of the Chevenard thermobalance, for various precipitates:

| Precipitating reagent | Form in which weighed | Temperature limits |
|---|---|---|
| Ammonium hydroxide | $UO_3$ | 480-610° |
| Ammonium hydroxide | $U_3O_8$ | 745-946° |
| Ammonia (gas) | $U_3O_8$ | 675-946° |
| Pyridine | $U_3O_8$ | 745-946° |
| Ammonium benzoate | $U_3O_8$ | 691-946° |
| Hexamethylenetetramine | $U_3O_8$ | 745-946° |
| Tannin | $U_3O_8$ | 570-878° |
| Hydrogen peroxide | $U_3O_8$ | 811-946° |
| Hydrofluoric acid | $U_3O_8$ | 811-946° |
| Ammonium sulphate | $U_3O_8$ | 850-946° |
| Disodium phosphate | $U_2P_2O_{11}$ | 673-946° |
| Oxalic acid | $U(C_2O_4)_2$ | 100-180° |
| Oxalic acid | $U_3O_8$ | 700-946° |
| Cupferron | $U_3O_8$ | 800-946° |
| β-Isatoxine | $U_3O_8$ | 408-946° |
| 8-Hydroxyquinoline | $HUO_2(C_9H_6ON)_3$ | < 157° |
| 8-Hydroxyquinoline | $UO_2(C_9H_6ON)_2$ | 252-346° |
| Quinaldinic acid | $U_3O_8$ | 610-946° |

**ENGINEERING** (continued)

326 Speed tests on a single stage multijet glass pump. D. Clark. BI-55, Mar. 13, 1945. 5p.

Speed tests have been carried out on a single stage glass pump. The body of the pump is 2-in. diameter and the jet system consists of six individual jets arranged umbrella fashion. The fine side connection is 1 1/2-in. diameter. The mercury boiler is heated by external electric heaters. With the optimum heat input of 260 w, it has a maximum pumping speed of 24 liters per second at a fine side pressure of $2 \times 10^{-4}$ mm. It can be backed by an ordinary rotary pump.

327 Use of characteristic curves for pump-speed vs. pressure. Saul Dushman. Rev. Sci. Instruments 20, 139(1949) Feb. (Laboratory and shop notes).

A method is described for deriving the total period of time required to exhaust a vacuum system (from atmospheric pressure to some very low pressure) from the speed characteristic of the pump. The following expression is obtained:

$$t_2 - t_1 = V \int_{P_2}^{P_1} (d \ln P/S)$$

in which V = the volume of the system, P = the pressure in the system at an instant of time, t, and S = the pumping speed. If 1/S is plotted versus P on semi-log paper, then $t_1 - t_2$ can be derived by simply measuring or calculating the area under the curve within the appropriate limits by some approximation method. In the range between $P_1$ and $P_2$ for which S is constant, the calculation is simplified since $t_2 - t_1 = (2.30V/S) \log (P_1/P_2)$.

328 Application of the radioactive tracer technique to metal cleaning. J. C. Harris, R. E. Kamp, and W. H. Yanko. ASTM Bull. No. 158, 49-52(1949) May.

The technique of employing radioactive tracers for determining the cleanliness of metal surfaces is presented. The metal cleaning procedure is described, and the choice of radioactive element and synthesis of radioactive compound are briefly discussed.

329 Application of radio-isotopes in industry. Henry Seligman. Chemistry and Industry (London) 20, 311-16(1949) May 14.

The present applications of radioisotopes in industry are reviewed and possible further applications are noted. Application of the radioisotopes in industry can be made by using one of the following: (1) the ionizing power of the radiation; (2) the penetrating properties of the radiation; and (3) the ease with which disintegrating atoms may be detected. Some of the applications in each of these categories are discussed. A table of some particularly useful radioactive isotopes is given and the availability, and specific activity of some of these are discussed. 9 figures.

330 Industrial uses of radioisotopes . . . a bibliography. Iron Age 163, 60-61(1949) June 9.

Extracts from a bibliography of published material on industrial applications of radioactive materials is presented to aid in the dissemination of such information as is readily available. 68 references.

331 Radioactive tracers used in research on engine wear. P. L. Pinotti, D. E. Hull, and E. J. McLaughlin. Petroleum Engr. 21, C5-8(1949) June.

Radioactive tracers have been used successfully in developing an improved method for determining engine wear. The technique and results shown in this paper are an example of the application of radioactive materials in engine and petroleum product research. Other important uses are evident. For example, it is well adapted to the investigation of engine operating conditions such as speed, load, oil temperature, jacket temperature, air fuel ratio, and other variables. Similarly, the critical parts of transmissions, differentials, steering mechanism, and other parts can be evaluated under a variety of operating conditions.

ENGINEERING (continued)

332 Study of glass batch melting by radioactive tracing. Stig Lindroth. J. Am. Ceram. Soc. 32, 198-201(1949) June 1.

Radioactive emanation-producing tracers for the investigation of powders have been applied to (1) the determination of surfaces and surface changes (e.g., melting) and (2) the study of diffusion phenomena in relation to transformations and chemical reactions. Preliminary investigations of glass batches have indicated the usefulness of this method. In the application of the procedure, small samples of glass batch (0.2 g) are treated with radiothorium nitrate solution, dried and sieved, and heated at a constant rate of 10°C/min to 900-1000. The release of thorium emanation atoms as a function of the temperature is measured by their ionizing effect on a nitrogen current passing the sample into an ionization chamber connected to an amplifier and a sensitive galvanometer. Investigations using this method are described.

333 A new principle in controlled vacuum leaks. C. H. Bachman. Rev. Sci. Instruments 20, 219-20(1949) Mar. (laboratory and shop notes).

A completely different system for the introduction of controlled leaks into vacuum systems has been developed. Instead of introducing gas at a slow steady rate through a constriction, it is introduced in short bursts or pulses through a comparatively large opening. The amount of gas in each pulse as well as the pulse frequency is controlled. With such an arrangement dust particles can have no effect, and the leak rate can be adjusted through great ranges. Two arrangements for achieving this result are described. In one arrangement a metal shaft having pits in its surface is rotated so that each pit delivers its volume of gas to the evacuated pick-up tube and moves on to be recharged. (A good vacuum seal is maintained between pits). The capacity of this leak is governed primarily by the volume of the pits and the pit or pulse frequency. The bore of the pick-up tube is definitely out of the class of capillaries, being 1/8 in. or larger. Using a variable speed drive the leak rate may easily be adjusted over a 100-1 range. This type of leak has the great advantage that its capacity or leak rate can be predicted from a knowledge of the pit dimensions and operating speed (pulse frequency). Repeated measurements on a rotary pulsed leak showed the actual leak rate to check the calculated rate to within a few per cent at pressures below 1 mm Hg. The second controlled leak arrangement consists of a cam-operated valve. As the cam rotates the rubber cap opens and closes the opening to the pick-up tube. This possesses the advantage over the rotary leak of eliminating the necessity for vapor-producing lubricating oil. Such a pulsed leak, provided with a screw adjustment of cam position, easily controlled the pressure from atmospheric down to $10^{-4}$ mm Hg. Either the rotary or the valve type leak lends itself nicely to applications where a desired vacuum value is held by balancing the leak rate against the pumping speed. The results are even more striking, however, when the pulsing leak is turned on and off by a vacuum switch such as the $SMCI^2$ monitor, of the type recently described (Instruments 22, 33-36(1949)). Although the work to date has been in connection with vacuum systems, the pulsed leak principle should be useful in any application where it is desired to have control over the transfer of gas from a high pressure region to one at lower pressure.

334 A new vacuum gauge. Carlton F. Johnson. Rev. Sci. Instruments 20, 364(1949) May (Laboratory and shop notes).

Observations have been made on the variation of the motional impedance of a magnetostrictive transducer with air pressure on the face of the transducer. The transducer and its series tuning capacitance are made one arm of a resistance bridge so that when the bridge is balanced, only the change in voltage across the tuned circuit is measured. A circuit diagram and a curve showing the millivolts bridge unbalance as a function of the air pressure are shown. It is proposed that with suitable design features a transducer could be used as a vacuum gauge of a fundamental nature.

ENGINEERING (continued)

335 A simple water circuit for the quick-cooling system of vacuum diffusion pumps. C. Billington. Research. London 2, 134(1949) Mar.

A simple water-cooling circuit is briefly described which is suitable for use with vacuum diffusion pumps. The circuit has the advantages of simplicity of design (requiring a minimum of components) and provision for self-drainage. The latter will prevent a slight leak through the supply cock from reducing the temperature of the pumping fluid when the pump is operating.

MINERALOGY, METALLURGY AND CERAMICS

336 Measurement of radioactivity and temperature in narrow boreholes, and the development of instruments for this purpose. R. Guelke, J. C. R. Heydenrych, and F. Anderson. J. Sci. Instruments 26, 150-3(1949) May.

The development of instruments for measuring the temperature and radioactivity in boreholes, to determine the position of the various geological formations under special conditions encountered in South Africa, is described. Special mention is made of size considerations and of the necessity for making the instruments self-contained so as to enable a single insulated wire to be used for hoisting purposes.

337 The radioactivity of the earth. C. Festa and M. Santangelo. Ann. Geofisica I, 581-609(1948) Oct. (in Italian).

The various problems connected with geological radioactivity determinations are discussed, and the methods and instruments in use are reviewed in detail. Tabulated data on naturally radioactive materials are included.

338 The radioactivity of sediments. E. N. Tiratsoo. Petroleum 12, 117-22(1949) May.

Potassium is an element of considerable geological importance, since its radioactive isotope is a source of significant energy. This paper describes a method of rapidly determining the potassium content of evaporites and rock samples which has obvious potentialities in oilfield correlations. The technique may have especial application in salt dome areas or where drilling is being undertaken for valuable potash salts. The author concludes from the experimental data examined that the radioactivity of sedimentary rocks is largely related to their content of potassium.

339 Interfacial energies of metals. G. W. Sears. AECU-242, Apr., 1949. 31p.

Although the surface tensions of liquid metals can be and have been measured by well-known methods, a real need exists for the measurement of interfacial free energies of solid metals. At present, no generally accepted method of determining solid-solid interfacial tensions has been published. This paper presents a general picture of the need for such data and a critical literature survey of the subject of the methods of measurement of surface tension. Experimental methods of determining the interfacial free energies are reviewed with particular emphasis on the problem of solid-solid interfaces. Theoretical calculations of surface energies also are considered. 107 references.

340 Calcium and calcium-base alloys. W. Hodge, R. I. Jaffee, and B. W. Gonser. RAND Corporation Report R-123 (Battelle Memorial Institute) Jan. 1, 1949. 69p.

The almost unlimited availability of calcium bearing minerals and the low density of metallic calcium with its melting point higher than aluminum indicated that a preliminary survey should be made of the possibilities for calcium and calcium-base alloys as construction materials for aircraft and guided missiles. This report contains the information and conclusions resulting from such a survey. Calcium in the unalloyed condition is an extremely ductile light metal, whose mechanical properties on a strength-weight basis are on a par with unalloyed aluminum. Possibilities for developing alloys for constructional use are highly doubtful. The chief disadvantage of calcium is its

MINERALOGY, METALLURGY AND CERAMICS (continued)

poor corrosion resistance, which makes it unusable in the pure form. It is believed that this could not be improved to any marked extent by alloying, so some type of cladding would be necessary. Since calcium does not alloy with iron or stainless steel, prospects for cladding with these materials are poor. Cladding with corrosion-resistant magnesium or aluminum is more promising, if the boundary layer thickness of intermetallic compounds can be kept to a minimum. There are also meager possibilities for protection by coating with an organic material. The best procedure for appraising the possibilities of calcium appears to be to try to make a strong calcium-base alloy which would then be protected by a metallic or organic coating. There is little prospect that either effort would be "crowned" with success.

341 Metal to nonmetallic brazing. C. S. Pearsall and P. K. Zingeser. MIT Research Laboratory of Electronics Technical Report No. 104, Apr. 5, 1949. 21p. (NP-841).

This report has been prepared to summarize the results of a series of experiments on the brazing of both metals and nonmetallic materials with active metals such as titanium, zirconium columbium, and tantalum. This brazing technique has been carried out in controlled atmospheres and vacuum without the use of fluxes. The experiments described are of an exploratory nature, with little emphasis on the development of techniques for special applications. The method has been used in brazing a wide variety of materials, i.e., diamonds, sapphires, carbides, various ceramics, refractory oxides, glass, quartz, stainless steel and chrome-iron-type alloys. The active metals used in this brazing technique have the property of wetting both metals and nonmetallic materials equally well, producing exceptionally strong bonds which in many cases exceed the strength of the nonmetallic materials. 10 references.

342 Preliminary report on viscosity determinations on a potassium-sodium alloy. R. Ruskin, C. T. Ewing, and R. R. Miller. Naval Research Laboratory Report NRL-P-2931, Aug. 14, 1946. 10p.

An Ostwald-type viscometer has been used to measure values of viscosity on a potassium sodium alloy which was 43.4% potassium by weight. Viscosity of the alloy at 72°C was 1.267 relative to water at the same temperature. The values at higher temperatures were calculated from the volumes of alloy flowing per second at those temperatures, and the constant was determined for the apparatus at 72°C.

343 Production of metallic lithium and lithium salts—a survey. C. R. Witschonke. Naval Research Laboratory Report No. NRL-P-2704, Nov., 1945. 28p.

The present report outlines the factors to be considered in developing an economical process suitable for the commercial production of lithium materials. These factors include (1) available lithium raw materials, (2) processing requirements, (3) removal of lithium values from the ore, and (4) purification and conversion to the desired lithium material. All available information pertaining to these factors has been analyzed with respect to its accuracy and possible application to the present problem. The Kings Mountain, North Carolina spodumene ores appear to be the most attractive source of lithium raw materials due to the extent, uniformity, lithia concentration, and availability of the deposits. A preliminary concentration by froth flotation should yield ore containing 5-6% lithia, with an 80-90% recovery of lithium. For methods of recovering the lithium values from the ore, it is recommended that a research program be carried out with emphasis on a $CaO$-$CaCl_2$ high temperature replacement reaction to free the lithium, followed by a vacuum distillation to remove it from the ore residue. A similar process, in which a cheap sodium salt such as the chloride, sulfate or carbonate is the replacing agent, should also be investigated.

MINERALOGY, METALLURGY AND CERAMICS (continued)

344 Reactions of metals in high vacua. Earl A. Gulbransen and Kenneth F. Andrew. J. Phys. & Colloid Chem. 53, 690-711(1949) May.

The nature of chemical reactions occurring in vacuum and at high temperature on various metals is considered. These reactions are grouped into three classes: (1) those that form a gas as a result of a reaction; (2) those that react with gases in the vacuum; and (3) those that exchange one gas for another as a result of chemical reaction. Equilibria calculations are made where data are available on the reactions for the metals zirconium, tungsten, iron, chromium, and magnesium. The various reactions are discussed as sources and sinks in high-vacuum technique. An apparatus is described for studying these reactions at temperatures to 1200°C and at pressures of $10^{-6}$ mm Hg or better. A new type of high-temperature vacuum furnace tube is briefly described, which can be sealed to Pyrex and is vacuum-tight at 1200°C. Results are presented on the following problems: (1) the vacuum oxidation of zirconium, tungsten, molybdenum, and mild steel; (2) the formation of carbon monoxide by the reaction of carbon in the metal with the surface oxide for the alloy Nichrome V; (3) the volatilization of molybdic oxide and tungstic oxide; and (4) the oxidation and evaporation of magnesium. 25 references. 13 figures.

345 Studies, investigation and research on powder metallurgy of magnesium for the Army Air Forces. Dow Chemical Company First Quarterly Report, July 15, 1948. 15p. (NP-857).

The vertical cross jet and the spinning disc types of atomizer appear to be satisfactory methods for production of magnesium powder. The axial flow type of atomizer showed little promise. The spinning disc seems to be the only method of atomizing magnesium which might yield powder of small particle size in production quantities. A power reamer to clean out the orifice can be made and has been used quite satisfactorily when the metal orifice is 1/8-in. diameter or larger. There is no great change in particle size distribution as the metal orifice size is decreased in the cross jet type of atomizer if the metal pressure is simultaneously increased to keep the total metal atomized nearly the same. As the metal orifice diameter is decreased, the difficulties of keeping the orifice open multiply at a very rapid rate. The spinning disc cannot be given a real trial until a larger atomizer is built. This is particularly true if coarse powder is wanted.

346 Studies, investigation and research on powder metallurgy of magnesium for the Army Air Forces. Dow Chemical Company Second Quarterly Report, Oct. 13, 1948. 16p. (NP-858).

A satisfactory orifice design for the atomizer has been acquired. Vertical cross-jet atomizing has been found to give more trouble-free operation than the horizontal cross-jet. The pressure in the atomizing chamber increases with the rate of metal being atomized. The equipment works quite well except for build-up of metal around the orifice block and plastering on the atomizer walls. The use of argon definitely increases such plastering, while build-up on the orifice appears to be controllable by proper positioning of the gas nozzle. The large single egg-pump for molten metal gives trouble-free operation. Its intermittent nature is not objectionable with a dependable orifice reamer. Argon was found at least as difficult to dry as helium and, like helium, gives non-spherical powder, when moisture is present.

347 Studies, investigation and research on powder metallurgy of magnesium for the Army Air Forces. Dow Chemical Company Third Quarterly Report, Jan. 20, 1949. 20p. (NP-859).

Maximum and minimum production rates are found to be related to metal orifice diameter. Successful operation of a small batch atomizer for 39 independent runs shows that only 30 cu ft of natural gas are required to atomize 1 lb of magnesium. Natural gas gives better operation than helium or argon. A 7-ft diameter tank is not large enough for cross-jet atomizing. The combination of rusty equipment, rubbing friction, and accumulation of fine magnesium powder constitutes a certain hazard in operation with these powders. A Pauling oxygen-indicator revealed the presence of 1.16% oxygen in the argon. The source of this contamination was not determined.

MINERALOGY, METALLURGY AND CERAMICS (continued)

348 Studies, investigation and research on powder metallurgy of magnesium for the Army Air Forces. Dow Chemical Company Fourth Quarterly Report, May 6, 1949. 17p. (NP-860).

Increasing the flow of metal was found to aggravate operating difficulties. This limits the production rate of a single unit to about 300 lb/hr. Nozzle design was intensively studied; no new design appears better than the DeLaval-type nozzle.

349 The tensile strength of titanium at various temperatures. R. L. Bickerdike and D. A. Sutcliffe. Metallurgia 39, 303-4(1949) Apr.

An investigation is described which was carried out to determine the effect of temperature on the tensile strength of titanium of known composition.

350 Titanium. Bruce W. Gonser. J. Metals 1, 6-9(1949) Jan.

The occurrence of titanium and its ores are discussed along with the methods for producing it in metallic form. The physical metallurgy, properties and uses, and good combination of qualities of the metal are described. A diagram comparing the properties of commercially pure titanium, iron, and aluminum is given. Some properties of titanium are presented in tabular form.

351 Titanium and titanium alloys. Metal Ind. 74, 386, 389(1949) May 13.

The article discusses and presents data from articles on titanium which appeared in Metal Progress, (1949) Feb.

352 Activity of radioactive inclusions in igneous rocks. René Coppens. Compt. rend. 228, 176-8(1949) Jan. 10 (in French).

It has been shown by Hée (Compt. rend. 227, 356(1948)) that the radioactivity of igneous rocks is traceable to radioactive inclusions. The present author used the photoemulsion method for the determination of the U and Th content of rocks, by counting $\alpha$-tracks produced by such inclusions, per $cm^2$ and per sec. Rock powder was placed upon Ilford $C_2$ emulsions, the exposition time varying between 7 and 18 days. In most cases, prolonged trajectories meet upon a well delineated small surface corresponding to the inclusions. The formula used is that given by I. Curie (J. phys., (1946) Nov) which, after substitution of constants, has the form $N = 8.4KC(U) + 2.5KC(Th)$; here N is the number of trajectories, C(U) and C(Th) are the concentrations of U and Th, and K is a coefficient varying between 14 for granite and 31 for uranium oxide and thorite. Using as a second equation $C(Th) = 2.5C(U)$, the concentrations C(Th) and C(U) can be determined. The method was tested on seven samples of granitic sand and micaschist from Brittany. Their average contents was found to be about 10% U and 22% Th, with approximations of about 20%.

353 Formation of radioactive surface films on minerals. T. G. Church. National Research Council of Canada Report CRC-407, nd. 8p.

This report describes experiments performed to determine whether mineral surfaces could be made radioactive by undergoing exchange reactions with radioactive ions in solution. Such radioactive coatings, if selective, would serve as a means of differentiating between minerals in an ore and enable them to be separated mechanically by a Geiger counter operated device, such as the Lapointe ore-sorter. It was found that specific minerals in an ore can assume a surface radioactivity by undergoing reactions with radioactive ions in solution. It is essential that the mineral have a suitably tarnished or coated surface, for, in general, no exchange will occur on a fresh surface. It is suggested that the radioactivity so induced could be used in conjunction with a mechanical device to separate and concentrate valuable minerals or to control plant processes.

MINERALOGY, METALLURGY AND CERAMICS (continued)

354 Uranium resources. Nucleonics 4, 23-8(1949) May.

The occurrence of uranium in igneous rocks, hydrothermal vein deposits, sedimentary rocks, and other deposits of doubtful and complex origin is discussed as related to the percentages of uranium minerals usually found. The economic value of uranium is considered in terms of our estimated resources of that metal, and the program which has been adopted by the government to stimulate uranium discovery and production is summarized.

PHYSICS

355 Emission of ultraviolet radiation in gases traversed by $\alpha$-particles. René Audubert and Solange Lormeau. Compt. rend. 228, 318-20(1949) Jan. 24 (in French).

Curves are shown of the observed intensity of the ultraviolet radiation, emitted by argon, neon, nitrogen, air, and oxygen when traversed by $\alpha$-particles, as a function of the pressure. In the case of the biatomic gases (oxygen and nitrogen) and air, the intensity of the radiation is proportional to the square root of the pressure, whereas for argon and neon, (which are monatomic) the intensity is directly proportional to the pressure. The results are discussed and it is concluded that the ultraviolet radiations must be due to the de-activation of atoms or molecules which had been activated by the $\alpha$-particles. It is noted that the results obtained for hydrogen are somewhat complicated since in the pressure region between 1 mm and 30 mm of Hg the intensity is proportional to the cube root of the pressure, necessitating the existence of $H_3$ molecules as has been mentioned by Eyring, Hirschfeller, and Taylor (J. Chem. Phys. 4, 479(1936)).

356 Polarization of multiple scattered gamma rays. Lewis V. Spencer. National Bureau of Standards. nd. 10p. (NP-710).

A study has been made to determine the circumstances under which polarization of Compton scattered photons could be neglected in an investigation of the passage of gamma radiation through matter.

357 Analysis of neutrons in extensive showers. J. S. Levinger. Phys. Rev. 75, 1540-3(1949) May 15.

The experimental results of Cocconi-Tongiorgi indicating the presence of neutrons in extensive cosmic-ray showers (Phys. Rev. 75, 1532(1949)) have been analyzed quantitatively into the following elementary factors: (1) the transmission of the neutrons through paraffin, (2) the production of neutrons in paraffin, (3) the production of neutrons in lead, (4) the transmission of neutron producers through paraffin, (5) the transmission of neutron producers through lead, and (6) neutrons present in the atmosphere. It has been determined that the neutrons detected have a transmission corresponding to a mean energy of approximately 3 Mev. If the neutron counters are arranged in paraffin, the counting rate due to local neutron production in the paraffin is comparable to the counting rate due to neutrons in the atmosphere. The results obtained agree with those obtained by Cocconi-Tongiorgi.

358 Concerning new elementary particles in cosmic rays. A. I. Alichanian and A. I. Alichanow. Nature 163, 761(1949) May 14 (Letter to the editor).

Recent work is reviewed which has provided evidence of the existence of cosmic ray particles having masses exceeding that of mesons (Lattes et al, Nature 160, 453, 486(1947); Rochester and Butler Nature 160, 855(1947); Powell and Occhialini Nature 161, 551(1948)). The authors call attention to the fact that they reported the existence of such particles as early as 1946 (Doklady Akad. Nauk. S.S.S.R. 5, 129(1946)), although no mention is made of this by the aforementioned investigators.

PHYSICS (continued)

359 Cosmic rays. J. M. Jauch. Nucleonics 4, 39-51, 44-58(1949) April-May.

Present knowledge of cosmic rays is reviewed in a series of two articles. In the first, the discovery of cosmic rays and the experimental methods used in their study are reviewed. Some of the characteristics of cosmic rays such as the altitude dependence, various components observed, geomagnetic effects, and the latitude effect are described using the data of numerous investigators. The soft component of cosmic radiation is discussed in some detail and related mathematical expressions are derived. The second section of this review summarizes available information on the hard component of the radiation; the penetrating showers and stars are also discussed. Speculations on the origin of the primaries and the genesis of cosmic radiation are reviewed, and, as noted by the author, seem to emphasize the lack of knowledge about the origin of the primaries. 63 references.

360 Cosmic-ray underground. Satio Hayakawa and Sin-Itiro Tomonaga. Phys. Rev. 75, 1958-9(1949) June 15 (Letter to the editor).

The relationship between the intensity-depth curve obtained for underground cosmic rays (Prog. Theor. Phys. 3, 199(1948)) and the life-time of the $\pi$-mesons is considered. The previous calculation of the latter from the former is given with greater accuracy, taking into account the energy-loss of $\mu$-mesons passing through the crust of the earth. The results seem to indicate that the life-time of the $\pi$-meson thus obtained from cosmic-ray data is in agreement with that obtained at Berkeley for artificial mesons. In addition it is noted that only known electromagnetic processes are necessary in explaining the behavior of underground cosmic rays.

361 Heavy splinters in cosmic ray stars. A. Bonetti and C. Dilworth. Phil. Mag. 40, 585-7(1949) May.

A cosmic ray star produced by the emission of long range, heavy fragments in a sandwich arrangement of Ilford $C_2$ 300-micron plates (which presented an effective thickness of 600 microns) has been observed. The photograph, which is shown, is analyzed in detail. The star consists of 20 tracks, of which 10 are certainly protons, 4 are so short that it is impossible to determine their nature, 2 are $\alpha$-particles of low energy and 1 is possibly a deuteron. Two of the heavy particles of long range are $\alpha$-particles, whereas the other two particles have been identified as having Z values of 10 and 4, and emission energies of 260 Mev and 90 Mev, respectively. The total energy required to produce the observed disintegration has been estimated as about 650 Mev. If the energy represented by neutrons and high energy protons and electrons, which are not visible in the emulsion, is taken into account, the total energy of the event is about 1000 Mev.

362 An interpretation of mixed showers. Satio Hayakawa. Phys. Rev. 75, 1958 (1949) June 15 (Letter to the editor).

The recent data on mixed showers obtained by Chao (Phys. Rev. 75, 581(1949); 74, 962(1948)) has caused the author to extend his previous comments (Phys. Rev. 75, 1759(1949)), since the data indicated a greater frequency of occurrence of multiple cascade showers in mixed showers than had been anticipated. The possibility that there is some error in the experimental data originating in a selectivity of the apparatus toward large showers is considered briefly. Calculations are made which appear to rule out the decay process in mixed shower production. The possibility of introducing the charge acceleration of the charge mesons produced is noted. It is also suggested that, in order to obtain agreement with Williams' conclusion, that there is only a single core in an extensive air shower (Phys. Rev. 74, 1789(1948)), it might be possible that in the extreme high energy region too many mesons are produced to permit photon emission without interference.

363 $\lambda$-Mesons in air showers. G. Cocconi and K. Greisen. Nature 163, 810(1949) May 21 (Letter to the editor).

Previous evidence for the existence of $\lambda$-mesons in air showers (Jánossy and McCusker Nature 163, 181(1949) Jan 29) has been re-interpreted. Since the aforementioned results were evidently

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obtained using a lead shield of 15 cm thickness, or less, whereas at least 20 cm of lead is required to reduce the soft component of the showers to a level of intensity that is small compared with that of the penetrating particles, it is believed that the particles in question are photons and electrons rather than any kind of mesons.

364 Nuclear capture of $\mu$-mesons. D. H. Perkins. Nature 163, 682-3(1949) Apr. 30.

The stopping of $\mu$-mesons in nuclear emulsions has been investigated using emulsions consisting of microcrystals of silver bromide, about $0.2\mu$ in diameter, suspended in gelatin. A meson coming to rest in the emulsion would be expected, in general, to spend the last fraction of a micron of its range either entirely within heavy atoms, or in light atoms. Thus, the probability of the meson stopping in heavy or light atoms will be almost independent of the complicated processes of energy-loss at velocities lower than $5 \times 10^8$ cm/sec., and can be estimated from experimental data on stopping power. From the data it is calculated that $30 \pm 6\%$ of the single mesons fail to produce a decay-electron upon coming to rest. This result is in good agreement with that obtained by other observers (Brown et al, Nature 163, 47(1948)). Previous investigations have indicated that negative $\mu$-mesons stopping in light atoms undergo electron decay (Conversi et al, Phys. Rev. 71, 209(1947)), whereas those stopping in substances of high atomic number undergo nuclear capture. Both photographic plate (Golschmidt-Clermont et al, Proc. Phys. Soc. (London) 61, 183(1948)) and cloud chamber evidence (Chang, Phys. Rev. 74, 1236(1948); Seriff et al, Bull. Am. Phys. Soc. 24, 2, 16(1949)) indicate that few or none of such mesons produce nuclear disintegration stars in heavy elements. The results obtained are analyzed and it is concluded that the absence of a homogenous group of recoil tracks of approximately $1.7\mu$ range, indicates that the resultant momentum of a nucleus capturing a $\mu^-$-meson must be $\ll$ than 450 Mev/c. The minimum length of recoil observable is estimated as $0.5\mu$, corresponding to a recoil momentum of 150 Mev/c. From the data it is concluded that the capture of a $\mu^-$-meson leads to the process $\mu^- + P \rightarrow N + \nu$, where $\nu$ denotes a light neutral particle (neutrino?). This is precisely the interaction predicted theoretically (Serber, Bull. Am. Phys. Soc. 24, 2, 7(1949)) as a consequence of the $\mu$-decay of the $\pi$-meson, assumed to be of the form $\pi \rightarrow \mu + \nu$.

365 On the origin of high energy protons. Satio Hayakawa. Phys. Rev. 75, 1759-60(1949) June 1.

The origin of the electronic component found in both mixed showers and extensive showers is considered. Oppenheimer's suggestion (Phys. Rev. 73, 127(1948)) that this component may be attributible to the disintegration photons of neutral mesons is discussed and it is noted that this interpretation leads to several difficulties. The theory previously formulated by the author and Tomonaga (J. Sci. Research Inst. 43, 67(1948)) is treated. This theory attributes the origin of the soft component of the radiation to the production of photons by the charge acceleration taking place in nucleon-nucleon collisions and is based solely on the electromagnetic interaction (which is trustworthy up to the extremely high energy regions). The following expression for the total probability for the emission of a photon in a nuclear collision is given: $P \approx kA^{1/3} \times 4.7 \times 10^{-3}(\ln \xi)^2$ in which "A" is the atomic weight, $\xi$ is the Lorentz factor for the particle, and "k" is the probability of the nuclear collision. In order to explain the observed frequency of the accompaniment of electron showers by meson showers, it is assumed that "k" is not much less than unity. It is concluded that the aforementioned theory is a satisfactory explanation of the mechanism by which the electronic shower component is produced. Some experimental facts which could not be accounted for by the ordinary electron-primary hypothesis, e.g., the height of maximum shower frequency and the angular distribution, are also explained by this "electromagnetic interaction" theory.

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366 On $\pi$- and $\mu$-mesons in the penetrating component of cosmic radiation. Charles Peyrou and André Lagarrigue. Compt. rend. 228, 312-4(1949) Jan. 24 (in French).

A previously described experiment (Compt. rend. 225, 1304-6(1947)) on the measurement of the masses of mesons in cosmic radiation has been improved and repeated. The coincidence arrangement used is described and results obtained are tabulated as follows:

| | $n_\pi$ | $n_t$ | $\frac{n_\pi}{n_t}$ (%) |
|---|---|---|---|
| Lead filter 72 cm .... | 21 | 63 | 33 |
| 24 cm .... | 12 | 68 | 17.5 |

in which $n_t$ is the total number of mesons stopped, and $n_\pi$ and $n_\mu$ are the numbers of $\pi$- and $\mu$-mesons, respectively. From the data it is concluded that the presence of $\pi$-mesons at a 1,000 m altitude (under 72 cm of lead is almost certain). The data verify the results previously obtained by the authors.

367 On the relativistic variance of $\pi$-mesons. Bernard d'Espagnat. Compt. rend. 228, 744-6(1949) Feb. 28 (in French).

It is shown that it is possible to interpret the experimental data concerning the mean lifetime of the $\pi$-mesons and the average capture lifetime of the $\mu$-meson by nuclei by a convenient choice of the single arbitrary constant "g." The value of $g_\mu$ is determined as $1.6 \times 10^{-49}$; this is in agreement with the results of Tiomno and Wheeler (Revs. Modern Phys. 21, 144-152(1949)). The mean lives for $\pi$-$\mu$ and $\pi$-e transitions are considered and an argument for the existence of pseudo-scalar $\pi$-mesons is advanced. Further calculations, involving the choice of a single constant which takes into account the order of magnitude of the average $\pi$-lifetime, one average $\mu$-capture lifetime and the $\beta$-radioactivity, are also outlined.

368 On the spin of $\pi$-mesons. Gregor Wentzel. Helv. Phys. Acta 22, 101-4(1949) (in German).

It is probable that $\sigma$- and $\pi$-mesons, rather than $\mu$-mesons, are to be identified with the particles of Yukawa's theory of nuclear forces. The latter particles possess an integral spin, which, in the vector theory, is equal to 1. The determination of the mesons' spin would, therefore, present a particular interest. The theoretical basis for a discussion of possible methods for such a determination is insecure; accordingly, only suggestions of a speculative character can be made. In the case of a non-zero spin, polarization effects are to be expected, due to the coupling between the spin and the trajectory; these polarization effects may prove observable. In photographic emulsions, $\sigma$- and $\pi$-mesons, at points corresponding to the end of their range, produce "stars" or, as is the case with positive $\pi$-mesons, they undergo a $\mu$-meson disintegration. Theoretically, it is possible that a strong spin-trajectory coupling may give rise to an anisotropy in the distribution of the "star" particles or of the $\mu$-mesons, which would permit a determination of the polarization plane. Another anisotropic effect may be due to the fact that a small number of "stars" are produced before the end of the range is reached; statistics of such cases may reveal changes in the polarization occurring along the path. When, as in the Berkeley cyclotron, $\sigma$- and $\pi$-mesons cross a magnetic field H, precessional rotation of the polarization vector around the field axis takes place, whose angular velocity is geH/2mc, (here e and m are the charge and the mass of the meson, and g is the Landé factor). Since the angular velocity of the particle is eH/mc, the angle between the two directions changes along the trajectory, except when g = 2. This will cause corresponding changes in the effective cross-section of the nuclear processes in the photo-emulsion, in different points of a trajectory.

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369 On the stimulated decay of mesons. W. H. Furry and James N. Snyder. Phys. Rev. 75, 1265-6(1949) Apr. 15 (Letter to the editor).

The hypothesis previously advanced by Goldhaber, that extremely fast electrons which could give rise to the soft component of cosmic radiation by cascade processes might be provided by the stimulated decay of energetic mesons, has been investigated. A calculation was made using a meson which: (a) interacts symmetrically with the heavy particle and light particle fields, and (b) suffers a two-particle decay into an electron (positron) and an antineutrino (neutrino). The process considered is a third-order one: (1) a fast meson is absorbed by the nucleon, (2) is re-emitted, and (3) then decays. The expression for the transition probability for stimulated decay of an incident scalar meson of mass $\mu$ and of energy $E_0$, stimulated by an infinitely heavy nucleon, i.e., the ratio of the stimulated to the spontaneous decay constant, for $E_0 \gg \mu c^2$ is $R = 8\left(\frac{g^2}{\hbar c}\right)^2 \lambda\!\!\!^{-}_0 \, 3n \frac{\mu c^2}{E_0} \log \frac{E_0}{\mu c^2}$ where $\lambda\!\!\!^{-}_0$ is the Compton wavelength of the meson and n is the number of nucleons per $cm^3$. The lifetime of a meson of this type is not appreciably affected by its passage through matter. It is noted that to get a lifetime of the order of $10^{-23}$ sec, which would be necessary if the meson is to decay by interaction with the nucleons whose collision produced it, it is necessary that R have the value $10^{17} E_0/\mu c^2$.

370 On the theory of stochastic processes and their application to the theory of cosmic radiation. Niles Arley. John Wiley and Sons, Inc., New York, 1948. 240p.

The mathematical foundations of the modern theory of random or stochastic processes and a detailed account of the applications of this theory to the shower theory of cosmic rays are included in this text. The material presented is divided into three parts: (I) containing the mathematical theory; (II) the application of the theory to the cosmic ray processes; and (III) two further mathematical chapters, supplementing part I. In the discussion of the application of the theory to cosmic ray problems, the Gaussian and Furry models are supplemented with a third, the Pólya, model which depends upon two independent parameters and contains the two previous models as special cases. It is noted that the Pólya model is useful in that it permits separate adjustments of the first and second moment of the probability distribution by suitable choice of the two parameters. The author analyzes numerous data on cosmic rays and concludes that the Pólya distribution gives the best agreement with the data now available, although the necessity for further investigations is noted.

371 Origin of cosmic ray stars. J. B. Harding. Phil. Mag. 40, 531-45(1949) May.

Data were obtained on the stars produced in Ilford "Nuclear Research" emulsion coated on glass plates which were exposed at an altitude of 3650 m. In one group of plates, all the stars (except those produced by $\sigma$-mesons) were observed, whereas in another set only those with more than six long tracks were examined. The results obtained are given in the form of curves. From calculations based on these data, the mean momentum transfer from the incident particles to a heavy nucleus was determined as approximately 175 Mev/c; the momentum transfer to a light nucleus was determined as about 160 Mev/c. From (a) the average excitation energy of a star with N tracks, (b) the spread of this energy about the mean value, (c) the size distribution $(M_N)_{Light}$ and $(M_N)_{Heavy}$, the distribution of excitation energy, that is, the number of stars with excitation energy U to U + dU for the observed groups of heavy and light stars has been calculated. The most probable excitation energy for the heavy stars is ~100 Mev, and the mean is ~190 Mev. For the light stars the corresponding energies are ~100 and ~130 Mev. The energy transfer is thus approximately equal to c times the momentum transfer, where c = velocity of light. The results obtained are discussed in detail and it is concluded that the majority of cosmic ray stars observed in photographic emulsions may be attributed to: (1) fast neutrons which are not captured; (2) fast mesons which give up all their rest energy; (3) "heavy mesons" which are captured in the upper part of nuclei. The range-velocity relation for recoil fragments in photographic emulsions is treated in an appendix to the article.

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372 Relations between radioelectric solar emissions and cosmic rays. Jean F. Denisse. Compt. rend. 228, 467-9(1949) Feb. 7 (in French).

Previous correlations made by Swann (Phys. Rev. 43, 217(1933)) between sunspots and the production of electrons of high energies ($10^{10}$ ev) and temperatures ($10^{12}$ degrees), viewed as possible source of cosmic rays, are discussed. Data obtained by Biehl (Revs. Modern Phys. 20, 360(1948)) on cosmic rays at high altitudes are compared with Covington's data on the apparent temperatures of the sun as observed on 0.1 m waves (Proc. Inst. Radio Engrs. 36, 1947(1948)). The cosmic ray intensity measurements obtained are not in agreement with a uniform distribution of the energy spectrum which would result in a regular increase in intensity with the latitude. Instead several of the intensity measurements seem to be too high and these measurements correspond with periods of elevated radioelectric solar emission. The component of the cosmic radiation influenced by solar emission is approximately 1/6 the total radiation. The fact that this correlation is usually observed only at high altitudes is attributed to the fact that this component is relatively soft. Stars are also considered as a possible source of cosmic radiation.

373 Upper atmosphere research report No. I. H. E. Newell, Jr., and J. W. Siry. Naval Research Laboratory Report NRL-R-3358, June 17, 1948. 100p.

This report describes upper atmosphere research at the Naval Research Laboratory during the last three quarters of 1947 and the first quarter of 1948. A detailed study of the solar spectra obtained during the V-2 flights of October 10, 1946, and March 7, and October 9, 1947, is given. The experiments performed in the missiles fired on May 15, July 10, and October 9, 1947, and January 22, 1948, are discussed. A description is provided of the experimental techniques and apparatuses which were employed. Results in cosmic ray research and pressure and temperature studies are presented. A mathematical analysis of the geometry of cosmic ray Geiger counter telescopes is given.

374 Weather forecasting of free balloon flights in cosmic ray research. John Kain Fogg. MIT Laboratory for Nuclear Science and Engineering Technical Report No. 17 (Office of Naval Research Contract), Feb. 4, 1949. 49p. (NP-812).

The purpose of this report is to present a foundation of knowledge, experience, and methods for a meteorologist interested in the particular weather problems encountered in the cosmic ray project. The first part of this report explains the problems confronting the forecaster, the past procedures used in forecasting, and the sources and availability of weather information. The second section deals primarily with statistical data summarized to indicate what conditions might be expected on a climatological basis. A discussion and an analysis of an actual flight are included.

375 Investigation of Beth-Flo Gentile flow tube. P. E. Tausche, C. C. Williams, and R. N. Saleeby. AECU-245, Mar. 12, 1949. 27p.

In view of the fact that the Beth-Flo Gentile Flow Tube, a new flowmetering device, is claimed to have no straight run limitations, negligible resistance to flow, and greater pressure differential than orifices and Venturi tubes of similar pipe to throat diameter ratio, it was considered of interest to investigate the performance of such a flow tube. The straight run flow characteristics of the Gentile tube were determined. Using these data as a basis for comparison, the deviations in accuracy caused by the following flow disturbances were determined. (1) Valves and elbows were placed at various distances upstream from the flow tube. (2) Simulated scale corrosion of the tube surfaces was effected. (3) Simulated welding beads were inserted. (Internal beads resulting from welding the tube into a pipeline). The permanent head loss of the tube was ascertained. In addition the pressure differential indicated by the Gentile tube was compared with that of an orifice. All investigations were conducted over a Reynolds number range of $10^4$ to $10^5$. This fact places a limitation on the results. From the experimental data, it was concluded that a Gentile tube of 2 in. OD and 29/32 in. throat diameter should be placed 5 diameters downstream from a 90° elbow and 10 diameters downstream from a globe valve,

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if recalibration is to be avoided by maintaining deviations from straight run accuracy within 3%. Furthermore, the flow tube cannot be used for metering gases which roughen its surfaces, nor is it advisable to weld it into the pipeline without recalibration. The permanent head loss is 60 to 75% for pressure differentials up to 10 in. of water. The Gentile tube measures a differential head only 40% as great as that of an orifice of corresponding pipe to throat diameter ratio.

376 Comparative survey of ion guns-I. Max Hoyaux and Ignace Dujardin. Nucleonics 4, 7-9(1949) May.

The fundamentals of satisfactory ion-gun design are reviewed in the first of a series of three papers on the subject. The problems of mean free path for ionization and of gas flow are briefly considered from the theoretical viewpoint. The general and the specific requirements of ion sources are determined by the necessity to obtain an intense and easily focused pure monokinetic ion beam which is stable, simple to control, and operates with relatively low power consumption.

377 Deionization measurements of grid-controlled thyratrons. Frank M. Verzuh. MIT Research Laboratory of Electronics Technical Report No. 101, Mar. 8, 1949. (NP-840).

This paper describes a method of evaluating the deionization time of thyratrons by means of an accurately calibrated time sweep. The apparatus permits precise control of each of the pertinent parameters, such as the amplitude and duration of the currents and voltages during the conduction and post-conduction periods. The effect of the nature of the enclosed gas upon the deionization time is presented by a study of thyratrons containing argon, hydrogen, mercury vapor, and xenon gas as the active elements. The individual effects of each of the parameters in the tube and of the associated tube circuit are illustrated by suitable graphical plots. Finally, the relative merits of many commercial tubes operating under typical dynamic conditions are summarized by comparative graphs which illustrate the corresponding deionization times.

378 Determination of molecular weights by the gas density balance. G. A. R. Hartley and R. Parmella. BR-215, Mar. 25, 1943. 9p.

This report describes the construction and use of a simple gas density balance for the rapid determination of molecular weights to a fairly high degree of accuracy (1 in 1000) by comparison of the vapor density of the material under examination with that of a gas of known molecular weight.

379 Electron focusing in a demountable x-ray tube. J. S. Thorp. J. Sci. Instruments 26, 201-204(1949) June.

An account is given of the changes in focal pattern produced by alterations of filament setting and aperture dimensions in a "parallel-sided" focusing system used in an x-ray tube and maintained at filament potential. These patterns are characterized by the presence of two pairs of bands of which the spacing and intensity are critically dependent on the filament setting. Electron trajectories derived from electrolytic trough measurements do not correspond with the observed pattern variations. It is suggested that this discrepancy is probably due to the presence of space charge and to effects arising at the ends of the filament.

380 The electron microscope. Herbert Friedman and LaVerne S. Birks. Naval Research Laboratory Report NRL-H-2012, Mar. 16, 1943. 42p.

Uses of the electron microscope, magnification and resolving power, design, an electron diffraction adapter for the microscope, specimen preparation, and electron micrographs are discussed.

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381 Electronic computers for division, multiplication, squaring, etc. H. S. Sack, A. C. Beer, and H. W. Boehmer. National Defense Research Committee Report 14-435, Aug. 7, 1944. 56p.

The idea of building a computer on the basis of attenuators, in which the attenuation is regulated by the length of a square wave pulse, can be practically realized. The limit of precision is around .1 to .2%. In order to obtain this precision certain tolerances of circuit elements have to be met, but they are within the limits of manufacturing possibilities. The most serious drawback is the necessity of matching tubes in the circuit described in Part B. In general the circuit using clamping tubes requires less strict tolerances, though a certain choice of tubes for the attenuators is also probably necessary. The advantages of greater simplicity of this type of circuit as compared with the circuit using attenuators with double triodes, are somewhat offset by the fact that the precision mentioned above is only obtained for positive inputs. The circuit can be changed to work with negative inputs but the precision is approximately one-half as good. Also the output impedance is higher than that of the other type and has to be constant within narrower limits. Tests over long periods show that both circuits can be built in such a way that no adjustments are necessary over several days or even several weeks. Heater voltage changes do not affect the results. A change of plate supply voltage, however, affects the first type of circuit while it does not affect much the second type.

382 Final engineering report on the study of voltage regulator electron tubes. W. B. Field, L. J. Rueger, F. C. Todd, and H. R. Nelson. Battelle Memorial Institute. June 30, 1948. 59p. (NP-774).

The investigation includes an experimental study of the factors which influence the performance of VR tubes. Particular attention is given to the influence of gas pressure, gas purity, electrode shape, and electrode surface conditions. The effect of gas pressure and mixtures is being investigated with the object of obtaining more stable tubes which will operate at different voltages and have better regulation than existing tubes. Static and dynamic characteristics of commercially available regulator tubes are presented. Experimental voltage regulator tubes were built and their characteristics measured in order to determine the factors that influence their performance. 58 references.

383 Ionization gauge pressure switch. C. J. Milner and I. M. Watt. J. Sci. Instruments 26, 159(1949) May 11.

An automatic switching system designed for the protection of filaments of ionization gauges and associated apparatus is described and both simplified and complete circuit diagrams of the pressure switch circuit are shown.

384 New electron multiplier photo-tube. T. Coor. Office of Naval Research London Branch, Jan 20, 1949. 7p. (NP-709).

The tubes are characterized by their low dark current, high signal to noise ratio, high quantum efficiency, high electrical and mechanical stability, and large solid angle of sensitivity. At the present time, two types of the new photo-multipliers are being made. The main difference between the two types is the arrangment of the photo-sensitive surfaces and the number of multiplier stages. Photographs of the two types are shown. Type 4588 has its photocathode deposited as an opaque film on the inner side of the glass envelope. The projected cathode area is about 20 sq cm. The light input to this tube should enter from the side of the tube. Type 5031 is the tube that was developed for scintillation counter work. In this tube the photo-cathode is deposited as a transparent film on the end window of the envelope. Sources of light placed in contact with the window will subtend almost $2\pi$ solid angles with the cathode.

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385 A torsion balance for measuring forces in low density gas flows. I. Estermann and E. D. Kane. J. Applied Phys. 20, 608-610(1949) June.

A torsion balance, designed to measure the force on a flat plate (or one of some other simple geometry) in a low density gas flow, is described. The balance has been used with two interchangeable torsion member sizes, with diameters of 0.00064 and 0.00090 in., which measured forces up to a maximum of 0.6 mg and 2.4 mg, respectively. Calibrations (obtained in still air using weights) were reproducible within $\pm$0.005 mg and $\pm$0.04 mg for the two sizes. Data obtained for a flat plate in a gas stream under large molecular mean free path conditions are presented.

386 The development of the isotopes distribution program. Paul C. Aebersold. Chem. and Eng. News 27, 1430-4(1949) May 16.

A review is made of the applications and dissemination procedures of radioactive products. Future areas of opportunity in this field are pointed out.

387 Isotopic weights of the fundamental isotopes. Kenneth T. Bainbridge. National Research Council Nuclear Science Series Preliminary Report No. 1, June 1948. 23p. (NP-849).

This report is, with some additional data, identical with a portion of a paper presented September 23, 1947, to the Solway Congress in Chemistry. The accurate determination of isotopic weights is stressed as being of great importance; the use of these accurate values in combination with the energy data from nuclear reactions makes it possible to check experimentally the equivalence of mass and energy, $\Delta E = \Delta MC^2$. A discussion with new experimental data, on $H^1$, $D^2$, $C^{12}$, the neutron, $T^3$ and $He^3$, the neutrino and $He^4$, is presented. Tabular data on fundamental H.D.C.O. doublets, reaction energy values, mass spectrograph doublets, and isotopic weights of Li, Be, and N are included. 23 references.

388 Natural variations in the isotopic content of sulphur and their significance. H. G. Thode, J. Macnamara, and C. B. Collins. Can. J. Research 27, 361-373(1949) Apr.

Mass spectrometer abundance measurements made on the isotopes of sulphur for samples obtained from a wide variety of sources show considerable variations. The isotopic ratios $S^{32}/S^{33}$ and $S^{32}/S^{34}$ were found to vary by as much as 2.5 and 5%, respectively. This would mean a corresponding variation of 10% in the $S^{32}/S^{36}$ ratio. Variations in the $S^{32}/S^{34}$ ratio were determined with a precision of $\pm$0.05%. In general, sulphates whether present as gypsum deposits or in solution were found to be enriched in the heavier isotopes of sulphur. On the other hand, the hydrogen sulphide of sulphuretted well waters was usually low in these isotopes even though present in the same solutions with the sulphates. These variations are in the direction expected from theoretical considerations. A correlation between crystallization temperature of pyrites and isotopic content has been found for crystals removed from the same specimen. However, no correlation was found between crystallization temperature or geological age and isotopic content for pyrite samples collected from different geographical locations. The results indicate that the changes in the isotopic content of sulphur that occur are related to the differences in chemical properties of isotopic sulphur compounds.

389 The rare isotope of helium, $He^3$; A key to the strange properties of ordinary liquid helium, $He^4$. F. London. Nature 163, 694-6(1949) Apr. 30.

The theoretical explanations which have been advanced to explain the unique properties of liquid helium II are reviewed. It is noted that recent work (Osborne et al, Phys. Rev. 75, 988(1949) Mar. 15) on the rare helium isotope, $He^3$, may be useful in establishing a satisfactory theory for ordinary liquid helium, $He^4$. The fact that liquid helium-3 showed no remarkable change in flow properties from 3° absolute down to 1.05° absolute, unlike helium-4 which becomes superfluid, is taken to constitute sufficient evidence that the Bose-Einstein condensation mechanism represents the correct explanation of superfluidity in helium-4.

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390 Isotope separation by Urey's method. R. Muylle. L'Industrie Chemique Belge 13, 17-23(1948) Jan.-Feb. (in French).

This is an outline of the theoretical basis of the isotope separation methods as developed by Urey and his co-workers. The principle is shown of the computation of the equilibrium constant of an exchange reaction by using methods of statistical mechanics. A mathematical analysis of the behavior of a rectifying column is made. Examples are given of isotope separations by Urey's method. 11 references.

391 A large mass spectrometer employing crossed electric and magnetic fields. Thomas Mariner and Walker Bleakney. Rev. Sci. Instruments 20, 297-303(1949) Apr.

The progress made on a large crossed-field mass spectrometer, up to the cessation of work in 1940, is reported. The basic design features of this instrument were directed toward a resolution of 25,000 in order to permit its use for mass measurement. Although this instrument had been diverted to less exacting applications before development was sufficiently advanced to achieve this goal, data indicate that the instrument could probably be used to attain it.

392 Comparative survey of ion guns. Part II. Max Hoyaux and Egnace Dujardin. Nucleonics 4, 12-29(1949) June.

The various types of ion sources described in the literature are reviewed and compared under the following categories: (1) high-voltage canal-ray ion sources; (2) low-voltage capillary-arc ion sources (with probe); (3) ion sources with oscillating electrons and magnetic focusing; and (4) high-frequency ion sources. The particular requirements of sources for mass spectrographs and cyclotrons are also considered briefly. 86 references.

393 Direct detection of microwaves. B. A. Lengyel. Naval Research Laboratory Report NRL-R-3204, Nov. 21, 1947. 15p.

Phenomena dealing with the interaction of light with electric and magnetic fields in matter are analyzed for the purpose of exploiting them in the construction of a microwave receiver. A detecting device is described which employs temperature-sensitive phosphors. The instrument constructed has been tested for centimeter waves. Its functioning requires a very high incident power level. The possibilities for increasing the sensitivity of such an instrument are analyzed theoretically.

394 Preparation and use of tritium and deuterium targets. E. R. Graves, A. A. Rodrigues, M. Goldblatt, and D. I. Meyer. AECU-207, nd. 16p. Proposed for publication in Phys. Rev.

Methods are described for preparing Ta-H and Zr-H targets for economic use of tritium. Ratios of hydrogen isotope to metals of about 1.0 were obtained. The use of these targets for the production of fast neutrons by deuteron bombardment is discussed. The neutron yield of the best targets for 10 microamperes of 200 kv deuterons is $10^9$ neutrons per second.

395 Star fragments in oxygen and helium under bombardment by 90 Mev neutrons. James Tracy and Wilson M. Powell. AECU-251, May 4, 1949. 11p.

Stars produced by the neutron bombardment of the gas in a cloud chamber have been analyzed. The gas consisted of oxygen, helium and water vapor at a pressure of one-half atmosphere. Because of experimental difficulties only one oxygen and seven helium stars could be reasonably well analyzed. The possible fragments of the 5-prong oxygen star were a proton, triton, three alpha particles and a secondary neutron. The possible fragments of the seven helium stars are tabulated below:

| | |
|---|---|
| Stars Nos. 1 and 2 | $2H^2 + n^1$ or $H^2 + H^3$ |
| 3 and 4 | $H^1 + H^3 + n^1$ |

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5 $2H^2 + n^1$
6 $H^1 + H^2 + 2n^1$
7 $H^1 + H^2 + 2n^1$ or $H^1 + H^3 + n^1$

396 Angular distribution of the scattering of slow neutrons by deuterium gas. J. A. Spiers. National Research Council of Canada Report CRT-417, Apr. 1949. 54p.

Hamermesh and Schwinger (Phys. Rev. 69, 145(1946)) have given an expression for the differential cross-section of scattering of slow neutrons of known energy by deuterium molecules. This expression is referred to axes in which the center of mass of the system incident neutron plus deuterium molecule remains at rest. The present paper derives an expression for the differential cross-section, referred to axes at rest in the laboratory, for scattering of a beam of monokinetic neutrons of known energy by deuterium gas at a known temperature. The effect on the angular distribution of the thermal velocities of the molecules before collision is accurately taken into account in this expression. This calculation is given. The expressions obtained have been computed for a neutron energy of .07 ev, and a gas temperature of 90°K (equilibrium ortho-para mixture). Results of the computation are given. The computed results are stated in terms of $a_{1/2}$ and $a_{3/2}$, the scattering lengths for the doublet and quadruplet states of neutron-deuteron interaction, respectively. It is shown that the presence of molecules in initial para states is necessary to make the determination of the ratio feasible. A comparison of the computed results with those obtained on a "semi-classical" picture of the scattering process is given and discussed.

397 The disintegration of carbon by fast neutrons. L. L. Green and W. M. Gibson. Proc. Phys. Soc. (London) 62, 296-300(1949) May 1.

The disintegration of $C^{12}$ into three $\alpha$-particles by inelastic scattering of fast neutrons has been studied by the photographic plate method. Measurements made on 168 of the stars formed by this disintegration have been used to identify the reaction and to obtain values of the cross-section for the process at neutron energies between 10.8 Mev and 14.5 Mev. Cross-sections of 2.3, 3.1, 9.0 and $15.7 \times 10^{-26}$ $cm^2$ were obtained for neutron energies of 10.8, 12.0, 13.2, and 14.5 Mev, respectively. No evidence was found for anisotropic scattering of the neutrons.

398 Introduction to the theory of diffusion and slowing down of neutrons-I. R. E. Marshak, H. Brooks, and H. Hurwitz, Jr. Nucleonics 4, 10-22(1949) May.

This is the first of a series of four papers which present a systematic development of the diffusion and aging theories for neutrons which must be considered in the design of a chain-reacting system. Starting with the Boltzmann equation, an attempt will be made to particularly note the approximations which have been used in deriving the theories, thus specifying the limits to the validity of the theories. Part I is concerned with diffusion theory only. Both rigorous and approximate solutions of Boltzmann's equation are obtained and discussed for various physical conditions. Boundary corrections to the diffusion theory are noted in detail. Related mathematical proofs are given in appendices to the article. (This series has been compiled from notes taken by Brooks and Hurwitz on lectures by Marshak which were given at the General Electric Company in 1946. A large part of the work described will appear in the National Nuclear Energy Series). 28 references.

399 Monoenergetic neutrons from charged particle reactions. A. O. Hanson and R. F. Taschek. National Research Council Nuclear Science Series Preliminary Report No. 4, nd. 30p. (NP-852).

The primary emphasis in the discussion is on those reactions which have been most widely used as sources of monoenergetic neutrons. The reactions, which are discussed in detail, are those involving light nuclei, namely $D(d,n)He^3$, $Li^7(p,n)Be^7$, and $C^{12}(d,n)N^{13}$. With tritium having recently

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become available for use as either a projectile or as target material, the reactions $H^3(p,n)He^3$ and $H^3(d,n)He^4$ have already proved useful as sources of monoenergetic neutrons. Neutron energies obtainable from these reactions are shown as a function of the energy of the incident particle. The reactions $V^{51}(p,n)Cr^{51}$, $Sc^{45}(p,n)Ti^{45}$, and other (p,n) and (d,n) reactions are also discussed. 49 references.

400 Neutrons from alpha emitters. Herbert L. Anderson. National Research Council Nuclear Science Series Preliminary Report No. 3, Dec., 1948. 23p. (NP-851).

This survey report covers primary thick target neutron yields from polonium alphas and from 9-Mev alphas produced by cyclotrons; radium-beryllium, radium-boron, and polonium-boron neutron sources; and neutron yield and energy distribution from the several sources.

401 On the diffusion of thermal neutrons. Maurice Nuyens and Carl Grosjean. Compt. rend. 228, 245-6(1949) Jan. 17 (in French).

The following expression is obtained for $\varphi_n(r)dr$, the exact elementary probability that a thermal neutron from a point source will undergo the nth elastic collision at a distance between r and r + dr from the point source:

$$\varphi_n(r)dr = \frac{2rdr}{\pi\lambda_s^n}\int_0^\infty (\text{arc tg}\lambda u)^n \left[\frac{\sin ru}{u^{n-1}}\right] du \qquad (n = 2, 3, \ldots).$$

The material medium is assumed to be infinitely large, homogenous, diffusing, and absorbing, and each collision is considered to be isotropic; $\lambda$, $\lambda_c$, $\lambda_s$ refer to the total mean free path, the mean free path for capture, and the mean free path for diffusion, respectively. By summation an expression for the total density of the thermal neutrons for a stationary distribution is obtained which is in agreement with the results obtained by Bothe (Z. Physik. 119, 493(1942)).

402 On the relativistic generalization of the integral-differential equation for the diffusion of neutrons. Mircea Drăganu. Compt. rend. 228, 367-70(1949) Jan. 31 (in French).

A relativistic generalization of the equation obtained by Halpern, Lueneburg, and Clark (Phys. Rev. 53, 173(1938)) has been obtained. The point of departure is the invariance of the relation to a Lorentz transformation of the number of particles N contained in an element of volume, V. The following expression is obtained:

$$\sqrt{I + \frac{Q^2}{c^2}}\frac{\partial W}{\partial t} + (\vec{Q}.\ \text{grad}\ W_0) = \int W_0(x, y, z, Q'_x, Q'_y, Q'_z, t)$$
$$\times\sqrt{I + \frac{Q'^2}{c^2}}\,\Phi(Q_x, Q_y, Q_z, Q'_x - Q_x, Q'_y - Q_y, Q'_z - Q_z)\,dQ'_x dQ'_y dQ'_z$$
$$+ W_0(x,y,z, Q_x, Q_y, Q_z, t)\sqrt{I + \frac{Q^2}{c^2}}\left[\Gamma(Q_x, Q_y, Q_z) + \Omega(Q_x, Q_y, Q_z)\right],$$

in which n is the corpuscular density, $Q_x$ etc. are the generalized velocity spatial components, and W is the probability that a particle will be found in the volume element with a particular velocity.

403 Simultaneous slow neutron fission of $U^{235}$ Atoms. I. Individual and total rates of decay of the fission products. H. F. Hunter and N. E. Ballou. Naval Radiological Defense Laboratory Report ADC-65, Feb. 24, 1949. 79p.

It is assumed that 10,000 atoms of $U^{235}$ simultaneously undergo fission by slow neutrons, yielding 20,000 fission product nuclei. The rates $A_x(t)$ of disintegration for each fission product x are computed for 26 different times after fission, from zero to about 300 years. On the basis of these data, the gross decay function A(t) = total number of disintegrations per minute at time after fission is computed and

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plotted. Tables and graphs are presented giving the total activity and the percentage of total activity contributed by various nuclides and by various elements as a function of time after fission.

404 Energy levels of light nuclei. T. Lauritsen. National Research Council Nuclear Science Series Preliminary Report No. 5, nd. 55p. (NP-853).

The present article summarizes information on light nuclei systematically and is essentially a supplement to an earlier paper by W. F. Hornyak and the author (Revs. Modern Phys. 20, 191,(1948)) of the same title, incorporating new information, and in some cases citing older references which were overlooked in that compilation. Information is contained on the following isotopes: $Li^7$, $Li^8$, $Be^7$, $Be^8$, $Be^9$, $Be^{10}$, $B^{10}$, $B^{11}$, $B^{12}$, $C^{12}$, $C^{13}$, $C^{14}$, $N^{13}$, $N^{14}$, $N^{15}$, $O^{16}$, and $Ne^{20}$. 251 references.

405 Is there a neutrino? John K. Major. Yale Sci. Mag. 23, 9-10, 14, 24, 26(1949) May.

The experimental and theoretical grounds on which the existence of the neutrino has been postulated are reviewed. It is concluded that extensive additional laboratory and theoretical work will be necessary before the existence of the neutrino can be considered an established fact.

406 Nuclear chemistry. Walter J. Blaedel. NEPA Division Report NEPA-1010, May 9, 1949. 163p.

The material in this volume was presented in a series of lectures during the NEPA Seminar, Summer, 1947, at Oak Ridge, Tennessee. The volume is divided into the following chapters: Types of Nuclei and Stability Rules; The Radioactive Decay Series; Radioelements of Lower Z, and the Missing Elements; Radiation Chemistry; Measurement of Radiation; Characterization of Radiation; Methods of Radiochemistry; Chemical Separation on the Tracer Scale; Chemical Problems of Piles; and Application of Nuclear Techniques to Ordinary Chemical Problems.

407 Nuclear electric quadrupole moments and quadrupole couplings in molecules. Bernard T. Feld. National Research Council Nuclear Science Series Preliminary Report No. 2, Sept. 1948. 21p. (NP-850).

A table of nuclear quadrupole moments and quadrupole couplings in various molecules is presented. This table includes all the data available up to April 30, 1948. The table is preceded by a discussion of the methods of measuring nuclear electric quadrupole moments. 57 references.

408 Contraction of the instantaneous orbit at injection in a betatron. F. F. Heyman. Phys. Rev. 75, 1951-2(1949) June 15 (Letter to the editor).

A method of orbit contraction has been achieved on a 20 Mev betatron by the process of applying a negative bias to the silver coating of the vacuum chamber, relative to the anode of the injector. The azimuthal component of the field due to the potential difference between the anode and the silver coating is strong over a small region immediately in front of the injector, and decreases gradually over a considerable fraction of a revolution. The results obtained in tests carried out at injector voltages of 8 and 11 kev are given in the form of curves of the relative optimum emission as a function of the bias voltage. The maxima of these curves correspond to 2.1 and 2.7 cm contraction at 8 and 11 kev, respectively. With the optimum bias required for 11 kev injector voltage, the x-ray output of the betatron was 9 r/min at 1 meter, measured in a Victoreen thimble chamber shielded by a 1/4 in. lead sheath with 2/3 full excitation on the magnet. The results are in agreement with Kerst's explanation of the mechanism by which the electron beam in a betatron is caused to miss the injector for the first few revolutions after injection (Phys. Rev. 74, 503(1948)).

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409 A large straight through vacuum valve for Van de Graaff generators. B. Jennings. Rev. Sci. Instruments 20, 366-7(1949) May (Laboratory and shop notes).

A vacuum valve for use with the beam tube of an electrostatic generator or external beam cyclotron is described which has the following characteristics that facilitate the changing of targets: (1) tightness in the closed position (maintaining the vacuum); (2) a large straight-through opening (to prevent beam splashing on valve parts); and (3) easily and quickly closable in case of accidents. A diagram of the valve is shown. The valve consists of a plate carrying an "O" ring rubber seal which is held mechanically against a polished valve seat. This mechanical force is supplied by a lever structure consisting of three bars, one of which is a radius bar to hold the valve plate centrally over the valve seat. The other two form a toggle joint which acts as the compression member of the lever system in the closed position of the valve, as they are locked together in the closed position of the toggle and act as one bar. The mechanical compression on the valve plate can be adjusted by the spacing nut and the thread in the valve plate. The operating shaft is brought outside through a commercial Wilson seal which is applied in the conventional way for rotating a shaft through a vacuum seal.

410 New accelerators of charged particles; a review of published data. A. P. Grinberg. Zhur. Tekhi. Fiz. 19, 1-29(1949) Jan.

In this first half of a review of literature on accelerators, works on the synchrotron are surveyed. (The second half will deal with the phasotron). Fifty references are given, mostly American; nine are Russian. It is stated that Veksler (Doklady Akad. Nauk. S.S.S.R. 43, 346(1944); 44, 393(1944)) preceded McMillan in the discovery of the mechanism of the "autophasing" of particles. Veksler (J. Phys. U.S.S.R. 9, 153(1945)), Andronov and Gorelik (Doklady Akad. Nauk. S.S.S.R. 49, 664(1945), and Rabinovich (J. Phys. U.S.S.R. 10, 523(1946)) contributed to the development of the theory of the synchrotron. Ivanenko and Pomeranchuk (Doklady Akad. Nauk. S.S.S.R. 44, 343(1944)), Artsimovich and Pomeranchuk (Zhur. Eksptl. i Teoret. Fiz. 16, 379(1946)) and Levin (Zhur. Eksptl. i.Teoret. Fiz. 17, 1159(1947)) studied the electromagnetic radiation of an electron moving in a circular orbit.

411 A new type of betatron without an iron yoke. A. Bierman. Nature 163, 649-50(1949) Apr. 23.

A betatron construction, in which the expensive and heavy iron yoke with its complicated pole-pieces has been eliminated, is described. This apparatus, although restricted in its applications, offers the advantages of lower cost, lighter weight, and greater beam intensity in experiments requiring short-wave x-ray output during a brief period (as in the investigation of nuclear processes with a Wilson camera). The main features of this apparatus are two coils in series, with a sealed-off acceleration tube between them, and a small iron core placed in the axis of the coils. The energy of the electrons accelerated may be varied up to 9 Mev by changing the core. Some of the dimensions are noted and a photograph of the apparatus is shown. The greater intensity of the beam is attributed to several factors, i.e.: (1) the strong damping effected by the high frequency field; (2) the short path of the electrons; (3) the large dimensions of the acceleration tube; and, (4) the more perfect axial symmetry of the magnetic field.

412 On the design of a radiofrequency Cockroft-Walton accelerator. Paul Lorrain. Rev. Sci. Instruments 20, 216-7(1949) Mar. (Laboratory and shop notes).

Cockroft-Walton generators, which are usually operated at frequencies of the order of a few hundred cycles per sec or less, have been investigated with respect to the possibility of using higher frequencies. The difficulties to be expected at high frequencies are considered and a tentative design for a 500-kv generator is given as follows: f = 5 megacycles per sec; C = 0.0012 $\mu$f, 30 kv; v = 15,000 volts; n = 17; ripple voltage about ± 50 volts for a load current of 1 ma. The total cost of such a high-

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frequency generator is estimated as less than that for the low-frequency design by a factor of 10. It is noted that the whole generator should be submerged in oil or pressurized (this would require special rectifier tubes designed to withstand the pressure) to reduce the length of the accelerating tube and to facilitate shielding the r-f and other stray radiations.

413 Pulsed oscillator for F-M cyclotron. J. W. Burkig, E. L. Hubbard, and K. R. MacKenzie. Rev. Sci. Instruments 20, 135(1949) Feb. (Laboratory and shop notes).

It has been possible to increase the dee voltage of the 41 in. f-m cyclotron by pulsing the oscillator, so that it is in operation only during the useful part of the f-m cycle. The cyclotron oscillator using four Eimac 304-TL tubes in parallel has been described by MacKenzie and Waithman (Rev. Sci. Instruments 18, 900(1947)). The pulsing has been obtained by replacing the grid leak resistor of the oscillator by the plate to cathode resistance of a 304-TH tube. When this tube is conducting, the oscillator operates normally. When it is not conducting, oscillation is stopped. A diagram of the circuit for the control tube is shown. The pulsing circuit is mounted in a shielded cage which is connected to the grids of the oscillator tubes. The cage voltage to ground is equal to the oscillator plate supply voltage plus grid bias. Installation of this pulse circuit has allowed a 50% increase in dee voltage with one-half the previous plate dissipation. The present normal average power consumption, under pulse conditions, is approximately 4 1/2 kw input for 12 kv on the dee, although the tubes, operating with their present efficiency, will allow a 6-kw input. Operation at the higher power level is more unsteady due to frequent tripping of overload relays.

414 Some calculations on the $\gamma$-ray dose produced by a 14-Mev betasynchrotron using an internal target. D. J. Allen-Williams and R. K. Appleyard. Proc. Cambridge Phil. Soc. 45, 305-10(1949) Apr.

Calculations have been made to determine the relationships between the measured $\gamma$-ray dose, mean electron current, and the nature and shape of the internal target of a machine of the 14-Mev $\beta$-synchrotron type, in which fast electrons strike an internal target. The investigation was made in order to assess the factors which will determine the magnitude and distribution of the $\gamma$-ray emission from such machines as they may be applied to biological work. An expression for q(E), the overall efficiency for energy transfer by the process (bremsstrahlung$^+$ Compton recoil), is obtained for the case of a thin target (in terms of the target thickness d of a material of density $\rho$, atomic number Z, and atomic weight A) as a function of $E_t$, the total energy of an incident electron in units of $m_0c^2$. An approximation more suitable for computation at the high electron energies encountered in the synchrotron is then given as $q(E) = 2\bar{\phi}N_0 (\rho/A)d \cdot p(x)$, where x is the kinetic energy of an incident electron in units of $m_0c^2$ and M is Avogadro's number. The variation of p(x) with x, or with energy in Mev, is shown. The effect of multiple passage through the target, which experiments show is an important factor (and related to the focusing action of the magnetic field in the synchrotron), is considered. For electrons leaving the target after first transit with angular distribution $\exp(-\theta^2/2\theta_0^2)$, and striking the target again on the sth revolution the mean radial displacement into the target is $\bar{x}_0 = (2/\pi)^{1/2} \frac{R\theta_0 \sin 2\pi n_i s}{n_i}$, and the mean deviation in angle is $\bar{\alpha} = (2/\pi)^{1/2}\theta_0 \cos 2\pi n_i s$. For tungsten targets of the type considered, at 12 Mev, $\theta_0 = 3.5°$. The characteristics of scattered groups of electrons when refocused on the target are given in terms of tabulated representative values of $\bar{x}_0$ and $\bar{\alpha}_0$ for a number of values of "n". Schiff's calculations were applied (Phys. Rev. 70, 87(1946) . It is noted that the combination of effects due to scattered electrons with the narrow "first transit" photon beam may well lead to skewness in either sense, depending on the value of the field exponent, n; by close control of the target's shape and size, and of n, it might be possible to utilize this to produce desirable types of angular distribution in the emergent $\gamma$-ray beam. Thus it might be possible to produce narrower beams than otherwise possible.

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415 Monte Carlo method — a popular description. N. Metropolis and S. Ulam. AECU-233, nd. 10p. Proposed for publication in Am. Statistician

A computational method is presented and discussed, the mathematical theory of which is indicated by the following. The process is a combination of stochastic and deterministic flows. It consists of repeated applications of matrices, as in Markoff chains, and completely specified transformations,e.g., the transformation phase space as given by the Hamilton differential equations. One feature is that it allows the acquisition by operators on functions obeying a differential equation without the point-by-point knowledge of the functions which are solutions of the equation. Thus the values of the first few moments of a distribution, or the first few coefficients in the expansion of a solution into a Fourier series, may be determined without the necessity of first obtaining the function itself.

416 Helmholtz-Rayleigh flow streamlines and equipotentials: Report No. 1. Peter F. Strong. AECU-247, Apr. 1949. 40p.

The Mark I Automatic Sequence Controlled Calculator was used to compute a number of streamlines of the Helmholtz-Rayleigh flow with wake cavity past a flat plate at three angles $\alpha$: 90°, 45°, and 15°. The computations were made over three meshes of W, the complex potential, for each angle $\alpha$.

417 Examination of porous materials which are being considered for use in ionic diffusion experiments. L. T. Newman and T. E. Wilmarth. AECU-250, Feb. 9, 1948. 7p.

Samples of porous stainless steel, porous tungsten, porous pyrex fritted glass filters, and porous Selas filters have been studied by the metallographic examination of polished sections and by the measurements of the air pressure required to force water out of the pores (Bechold method). Results are tabulated and micrographs included.

418 Discrepancies between physically and chemically determined atomic weights for the elements between silver 47 and iodine 53. J. R. White and J. H. Buck. Phys. Rev. 75, 1619-20(1949) May 15 (Letter to the editor).

The elements in the atomic number range 47 (Ag) to 53 (I) exhibit discrepancies between their physically and chemically determined atomic weights which are discussed. The deviation between the atomic weights based on physical data and those based on the 1947 International chemical values have been plotted as a function of mass number. It is noted that this curve possesses a maximum at mass number 115 which is coincident with the unexplained minimum which has been observed in the abundance curve of the isotopic species obtained in uranium fission. The author notes that this may prove to be only an interesting error coincidence. However, the results obtained indicate the necessity for a re-examination of either the chemical or the physical data (and possibly of both) to resolve the discrepancies in the atomic weights.

419 The establishment of the absolute scale of temperature below 1°K. A. H. Cooke. Proc. Phys. Soc. (London) 62, 269-78(1949) May 1.

Experiments are discussed establishing the relation of the absolute thermodynamic scale of temperature below 1°K to the magnetic scale obtained by the extrapolation of Curie's law. The experimental results on iron ammonium alum, manganous ammonium sulphate, and chrome potassium alum are compared with the theoretical calculations of Onsager (J. Amer. Chem. Soc. 58, 1486(1936)) and Van Vleck (J. Chem. Phys. 5, 320(1937)). The method used consisted in determining the heat input to the salt and the change in its entropy as functions of the magnetic temperature. As it is most important that there should be no loss of water of crystallization, the specimens were prepared by selecting large crystals of the salt, grinding them to powder and immediately compressing the powder in a hydraulic press to a pressure of about 2 tons/cm$^2$: This process produced cylinders which could be turned in a lathe and finally ground to a spheroidal shape, usually 5 cm long and 1.25 cm in diameter. The experimental values obtained for the Curie points were decidedly higher than the calculated

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values, and exceeded the calculated values for infinite cylinders, which are the highest given by any theory of magnetic dipole-dipole interaction. It is concluded that though the effect of the crystalline field is successfully treated by the theory, there are further interaction effects which have still to be explained. 15 references.

420 Note on Monte Carlo method. L. C. Merrill. Fairchild Engine and Airplane Corporation Report No. NEPA-1013, May 10, 1949. 6p.

A fourth method of easing the difficulties encountered in applying a Monte Carlo calculation to a highly attenuating shield is presented which does not appear in NEPA-860-STR-10 (Dec. 30, 1948). The method possesses the property that all the neutrons sent into the shield emerge or go back to the source, while the statistics can still be made good. A calculation at each collision is an added necessity.

421 Numerical solution of linear integral equations. Alan J. Perlis. MIT Servomechanisms Laboratory, Sept. 16, 1948. 50p. (NP-786).

This report is a survey of numerical methods for solving integral equations. Only linear equations of real variables are considered. There are three important types of such equations:

(a) The Fredholm equations of the second kind

$$f(x) = g(x) - \lambda\int_a^b K(x,y)\, f(y)dy \qquad \text{(non homogeneous)}$$

$$f(x) = \lambda\int_a^b K(x,y)\, f(y)\, dy \qquad \text{(homogeneous)}$$

(b) The Volterra equation

$$f(x) = g(x) + \int_a^b K(x,y)\, f(y)dy$$

and

(c) The equation of the first kind

$$g(x) = \int_a^b K(x,y)\, f(y)dy$$

In each of the above equations the function f(x) is obtained from the given functions g(x) and K(x,y). Under quite general conditions (a), and (b) possess unique solutions whereas (c) in general, has many solutions except under certain restrictive constraints. On the same level of importance as the design of a solving method for an equation is an appreciation of the status of errors in each step of the problem. Besides the usual numerical roundoff and truncation errors, all methods of solution introduce an important stability error caused by the lapse of a transcoendental problem into a discrete one. In general, the numerical methods show excellent stability (at least where unique solutions to the problem exist) due chiefly to the smoothing properties of integration. 20 references.

422 An international bibliography on atomic energy, Volume II — scientific aspects. Parts I, II, and V. United Nations Atomic Energy Commission, Feb. 14, 1949. 368p. (NP-854).

This preliminary edition contains a part of volume II, part I, Fundamental Nuclear Science. The remainder of part I and parts II and V are contained in AEC/INF/10-B.

423 Proceedings of the American Physical Society. Phys. Rev. 75, 1456-72(1949) May 1.

The 290th meeting of the American Physical Society was held at the University of California, Berkeley, on February 3-5, 1949. Included in the invited papers given were the following:

A new concept of catalytic hydrocarbon reactions from isotopic tracer studies. Otto Beeck.

Nuclear reactions produced by high energy neutrons. G. F. Chew and M. L. Goldberger.

Cloud-chamber analysis of the particles coming from carbon when bombarded by 90-mev neutrons. Wilson M. Powell.

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Recent experimental work at the radiation laboratory. Robert Thornton.
Abstracts of the contributed papers are given which include the following:
Quantum-theory restrictions on the general theory of relativity. M. F. Osborne.
Betatron injection. Leverett Davis, Jr., and R. V. Langmuir.
Measurements of cosmic-ray intensity at high altitudes. W. C. Roesch, A. T. Biehl, and H. V. Neher.
Latitude dependence of cosmic rays at 33,000 feet. A. T. Biehl, H. V. Neher, and W. C. Roesch.
Energy of cosmic-ray particles from ionization chamber and counter telescope data. H. V. Neher.
Extensive penetrating showers of cosmic rays. John Ise, Jr.
The range spectrum of cosmic-ray mesotrons. Lawrence S. Germain.
Theoretical values of mass and life-time of mesons. J. Barnóthy.
Compton-getting effect of cosmic radiation. M. Forró.
Automatic slit-width adjuster for an infra-red spectrometer. H. O. McMahon, Gilbert W. King, and R. M. Hainer.
Radiation accompanying meson creation. L. I. Schiff.
Decay time of $\pi$-meson. R. Latter and R. F. Christy.
The spins of the mesons. R. Serber.
A theorem on cross sections. G. C. Wick.
Determination of the rate of biochemical reactions. C. A. Tobias.
Purification and comparison of some organic phosphors for scintillation counters. John W. Irvine, Jr., and Raymond C. Sangster.
Life tests on self-quenching Geiger-Müeller tubes with halogen and polyatomic gases as quenching agents. F. W. Brown, III, P. J. Harris, and A. L. Klein.
Effects of temperature on naphthalene and anthracene scintillation counters. G. E. Koch and J. D. Graves.
A laboratory alpha-scintillation counter. J. D. Graves and J. P. Dyson.
Optical method for improving the counting efficiency of scintillation counters. R. H. Davis and J. D. Graves.
The Chi square test as a criterion for testing halogen-filled Geiger tubes. A. B. Willoughby.
Converter thickness corrections in gamma-ray spectroscopy. T. Lauritsen and W. F. Hornyak.
The beta-decay spectra of $B^{12}$ and $Li^{8}$. W. F. Hornyak and T. Lauritsen.
Gamma-radiation and nuclear pairs from $F^{19}$ + p. V. K. Rasmussen, W. F. Hornyak, and T. Lauritsen.
Cross sections for $C^{12}$ $(p\gamma)$ and $N^{14}$ $(p\gamma)$ reactions at low energy. E. J. Woodbury, R. N. Hall, and W. A. Fowler.
The scattering of protons by lithium. W. A. Fowler, C. C. Lauritsen, and S. Rubin.
The disintegration energy of $Be^{8}$. A. V. Tollestrup, C. C. Lauritsen and W. A. Fowler.
Beryllium-proton reactions and scattering. R. G. Thomas, W. A. Fowler, and C. C. Lauritsen.
Proton scattering by $Li^{7}$ and $Be^{9}$. E. Richard Cohen.
Angular distribution of $\gamma$-rays from lithium. R. F. Christy.
Relative magnetic moments of $H^{1}$ and $H^{2}$. E. C. Levinthal.
Cross sections for the reaction $T^{3}(d,n)He^{4}$ from 1 to 2.5 mev and its use as a neutron source. R. F. Taschek, A. Hemmendinger, and G. A. Jarvis.
Excitation function for $(\alpha,n)$, $(\alpha,2n)$, $(\alpha,3n)$ reactions on indium. G. M. Temmer.
Radioactive isotopes of Rh and Pd. D. T. Eggen and M. L. Pool.
Radioactive silver isotopes produced by photodisintegration of cadmium. R. B. Duffield and J. K. Knight.
Angular distribution of 14-mev neutrons scattered by deuterons. J. H. Coon, R. F. Taschek, and S. G. Forbes.
Neutron-proton scattering. R. Christian and E. W. Hart.
Camera for p-p scattering at 32 mev. Wolfgang K. H. Panofsky and Franklin Fillmore.

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Apparatus for measuring proton-proton scattering at 32 mev using proportional counters. B. Cork, L. Johnston, and C. Richman.

Elastic scattering of 90-mev neutrons. A. Bratenahl, R. H. Hildebrand, C. E. Leith, and B. J. Moyer.

Analysis of low energy proton-proton scattering experiments. G. F. Chew and M. L. Goldberger.

The energy spectrum of mesotron decay electrons. Robert B. Leighton, Carl D. Anderson and Aaron J. Seriff.

The decay products and the mass of the mesotron. Carl D. Anderson, Robert B. Leighton, and Aaron J. Seriff.

On nuclear capture of negative mesotrons. Aaron J. Seriff, Robert B. Leighton, and Carl D. Anderson.

Secondary particles from various nuclei bombarded with 90-mev neutrons. Herbert F. York.

Recoils of active fluorine$^{18}$ from 184-inch cyclotron bombardment. Warren Ehckrotte and Hugh Bradner.

Photographic plate confirmation of high energy deuterons from 90-mev neutrons on carbon. H. Bradner.

Inelastic scattering of protons. C. Levinthal, E. A. Martinelli, and A. Silverman.

On the injection of ions in the bevatron. R. L. Gluckstern and Lloyd Smith.

Production ratio of positive and negative mesons for various cyclotron target materials. Walter H. Barkas.

Meson mass measurements. Part I. Experimental method. Eugene Gardner.

Meson mass measurements. Part II. Experimental results. A. S. Bishop.

Meson mass measurements. Part III. Discussion of results. C. M. G. Lattes.

Stars in photographic emulsions initiated by heavy negative mesons. Frank L. Adelman and Stanley B. Jones.

Yield of negative mesons produced by high energy alpha-particles as a function of alpha-particles energy. Stanley B. Jones and R. S. White.

Excitation functions from deuteron bombardment of Cu. D. Bockhop, A. C. Helmholz, S. D. Softky, J. W. Rose, and T. Breakey.

Radioactivities of $Ag^{111}$, $Cd^{111}$, and $In^{111}$, by A. C. Helmholz, R. W. Hayward and C. L. McGinnis.

Study of $Cd^{115}$ isomers. R. W. Hayward and A. C. Helmholz.

Absolute cross section for production of heavy negative mesons by 380-mev alpha-particles. Vincent Peterson.

$Al^{27}(d,\alpha p)Na^{24}$ cross section. H. W. Hubbard.

Nuclear cross sections for 90-mev neutrons. N. Knable, J. DeJuren, and B. J. Moyer.

High energy gamma-radiation from 184-cyclotron target. B. J. Moyer, H. F. York, and R. Bjorklund.

Detection of very high energy protons by means of anthracene scintillation counters. L. Wouters.

Radiation field of the 184-cyclotron. W. K. Benson, Jr., R. L. Mather, B. J. Moyer, and Joseph Yater.

Kinetic energy release in fission induced by high energy neutrons. J. Jungerman and S. C. Wright.

A supplementary program included the following papers:

Inelastic scattering of protons from $Li^7$. W. A. Fowler, C. C. Lauritsen, and S. Rubin.

Report of initial performance of the Berkeley synchrotron. E. McMillan.

Acceleration of protons in the 184-inch Berkeley cyclotron. K. M. McKenzie.

Neutron diffraction in liquid elements. Owen Chamberlain.

An abstract of the first paper mentioned in this group is also given.

PHYSICS (continued)

424 Proceedings of the American Physical Society. Phys. Rev. 75, 1624-35(1949) May 15.

The 291st meeting of the American Physical Society was held on March 10, 11, and 12, 1949 at Western Reserve University and the Case Institute of Technology. Most of the papers presented were concerned with solid-state physics. Abstracts of the papers presented are given which include the following:

Electromagnetic properties of nucleons. L. L. Foldy.
Nuclear scattering. J. H. Williams.
Nuclear magnetic resonance in studies of solids. G. E. Pake.
The electron does not exist. Bayard P. Peakes.
Preliminary investigation of radiations from $I^{124}$. J. Lawrence Meem, Jr., and Fred Maienschein.
Disintegration of iodine$^{131}$. Daniel J. Zaffarano, Allan C. G. Mitchell, and Bernard D. Kern.
Coincidence studies on $Au^{199}$. Fred Maienschein and J. Lawrence Meem, Jr.
Energy distribution of fission fragments from $U^{235}$ and $U^{233}$. D. C. Brunton and G. C. Hanna.
Range distribution of the charged particles from the d-d reactions for 10-mev deuterons:
Differential elastic scattering cross section at 40 degrees, 30 degrees, and 20 degrees in the laboratory system. L. Rosen, F. K. Tallmadge, and J. H. Williams.
Angular distribution of photo-neutrons. Edwin P. Meiners, Jr., David R. Smith, and Lewis Slack.
Depolarization of neutrons during diffusion. Otto Halpern.
Variation of the equilibrium radius with time in a flux-forced field-biased betatron. E. C. Gregg, Jr.
Single production of mesons by $\gamma$-rays near threshold. L. L. Foldy.
Positon theory. Frederik J. Belinfante.
Precision gamma-ray wavelength measurements on $I^{131}$ with the 2-meter curved crystal focusing spectrometer. David A. Lind, James Brown, David Klein, David Muller, and Jesse DuMond.
Diffraction of slow neutrons by liquid $D_2O$. S. J. Czyzak and A. Wattenberg.
On the scattering of low energy $\gamma$-rays by protons. L. L. Foldy.

425 A pulse amplitude discriminator for fast short pulses. Dean A. Watkins. AECU-238, nd. 7p. Proposed for publication in Rev. Sci. Instruments.

An amplitude discriminator is described which involves the use of phototubes and organic crystals with resultant short fast pulses. An electrostatic beam deflection tube to be used with the discriminator is shown schematically. Characteristics of the tube are listed. A schematic circuit using this tube is shown and the operation is discussed. A plot of amplitude of output-pulse against amplitudes of input-pulse indicates the beam current times dynode-load-resistor. The output-pulse amplitude can never exceed this value. A method for increasing the deflection sensitivity of cathode-ray tubes is suggested.

426 Filter paper analyzer. Nuclear Instrument and Chemical Corporation. AECU-246, May 9, 1949. 6p.

The instrument to be designed is a system for recording alpha disintegrations. The unit will consist of a flat type probe, used to detect alpha particles on filter paper, a scaling unit having a scale of 64, with built-in amplifier, power supply and an electromagnetic register. The detector component will be a multi-wire air proportional counter of flat type with a window opening of 6 × 10 in. The instrument is to be used, presumably in a fixed location under normal indoor conditions.

427 A calibrated x-ray film badge dosimeter: final report. E. Tochilin, R. H. Davis, and J. Clifford. Naval Radiological Defense Laboratory Report ADP-78, Mar. 1, 1949. 33p.

An x-ray film badge dosimeter has been described which allows a quantitative interpretation of the roentgen dose received for effective x-ray energies of 15 to 150 kv. Both DuPont type 552 insensitive film and Eastman Radiatized type DF-7 dental film have been calibrated, and either can be used with

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the dosimeter. The film is covered by an echelon of three shields, plus an open window region. Tables are presented in which the ratio of densities between two adjacent shields determine a factor, which, when multiplied by the net density under one of the shields, gives the radiation dose directly in roentgen units. Data are also included which allow the dosimeter to be used to determine the quality of x-radiation, direct or scattered, striking the film badge. Proper processing of exposed films is accomplished by a one-point calibration check which consists of developing a pre-exposed standard film for various developing times until a net density of $1.5 \pm 0.15$ is obtained.

428 Canadian radiation instruments. National Research Council of Canada. Mar., 1949. 18p. (NP-771).

A report is submitted on radiation detection instruments available from Canadian manufactures. Electrical characteristics and uses of the following instruments are described: wide band amplifiers, general purpose scaling counters, pulse amplitude amplifiers, stable high tension sets, portable scintillation probe monitors, general purpose count rate meters, general purpose d-c amplifiers, Geiger and scintillation probe monitors, battery Geiger probe monitors.

429 Conditions for optimum luminosity and energy resolution in an axial $\beta$-ray spectrometer with homogeneous magnetic field. Jesse W. M. DuMond. Rev. Sci. Instruments 20, 160-9(1949) Mar.

In a $\beta$-ray spectrometer with axial homogeneous magnetic field, it is shown that optimum energy resolution and luminosity are obtained when the trajectories make an angle close to 45° with the field and that an annular resolving slit should be provided at a determined radial and axial location relative to the source. The combined effect of three independent sources of instrumental energy line width is analyzed for the optimum condition. Formulas are given for the optimum dimensions, the energy resolution and the luminosity. 14 figures.

430 Construction of beta-geiger counters from prefabricated thin wall tubing. F. E. Senftle, W. Havercroft, and P. Hernandes. Rev. Sci. Instruments 20, 370-1(1949) May (Laboratory and shop notes).

The new thin-walled etched borosilicate glass tubing (Code No. 7740) recently made available by the Corning Glass Works has been found to have certain advantages in the construction of Geiger counters, particularly those designed for $\beta$-detection. The tuning, which is especially useful when only limited glass-blowing facilities are available, is described in detail and the use of this type of tubing in the construction of counter tubes is described and illustrated. The wall thickness of the thin section has been found to be remarkably uniform, varying between 0.006 and 0.016 in. or 41-110 $mg/cm^2$. It is also noted that the uniform-bore tubing permits the use of a wide copper spiral or open screen as a cathode. These open cathodes allow a free passage of the $\beta$-particles into the active volume while still maintaining a uniform field. Another advantage of such tubes is the increased mechanical strength obtained; tests indicate that these tubes will withstand a maximum of 60 psi external pressure, suggesting their suitability for $\beta$-measurements under a considerable head of liquid.

431 Counter pulse shape. C. D. Thomas. Rev. Sci. Instruments 20, 147-9 (1949) Mar.

The shape of the decay pulse from a self-quenching counter depends on the circuit constants as well as on the motion of the positive ion sheath. This is considered mathematically and a formula is developed to take account of these factors in determining pulse height and form. In order to check this relation experimentally, data obtained from photographed single pulses are presented and compared with the calculated values. These curves cover a wide range of values of circuit resistance and capacity.

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432 Crystal counters-II. Robert Hofstadter. Nucleonics 4, 29-43(1949) May.

Experimental results which have been obtained by numerous investigators on various types of crystal counters are reviewed. The results are summarized and discussed and possible present and future applications of crystal counters are considered. It is noted that crystal counters should be useful as $\gamma$-ray detectors because of their high stopping power. The favorable characteristics of crystal counters include a high degree of linearity and a short resolving time; however, polarization is a serious handicap to the use of such counters. New materials are being investigated to find one suitable for use as arroom-temperature counter.

433 Detection of $\alpha$-particles by the destruction of foams. Robert Chaminade. Compt. rend. 228, 480-1(1949) Feb. 7 (in French).

The effect of $\alpha$-particles on thin layers of soaps has been studied with a view to finding a new method for the detection of such particles. The destruction of the bubbles of a foam bombarded by a polonium source emitting $7 \times 10^5$ $\alpha$-particles/sec for a solid angle of $4\pi$ has been studied. The solution used to produce the lather had approximately the following composition: 5% $CH_3(CH_2)^{10}O(SO_4NH_4)$, 6% ammonium sulfate, and 89% water, glycerine, sodium alginate, and lauryl alcohol. A lather 5 cm thick of approximately 1600 bubbles per cc was used. Corresponding to the course of the $\alpha$-particles, a bursting of the bubbles and a drop in the level of the lather was observed. The following expression for the average number of bubbles destroyed by $\alpha$-particles was obtained:

$$E = (V - v)\eta/nt$$

where "V" is the total diminution in volume during time "t" due to the bursting of bubbles, "v" is the diminution during time "t" due to the spontaneous bursting of bubbles (which would occur in the absence of $\alpha$-particle bombardment), "n" is the number of bombarding $\alpha$-particles/sec. and $\eta$ is the number of bubbles per unit volume (cc) of the lather. For v = 0.4 cc, V = 27 cc, t = 30 sec, at a temperature of 18°, E was determined as $0.1 \pm 0.05$. Several limitations of this method are noted and the possibility of applying it is discussed.

434 Detection of individual trajectories of $\beta$-rays in photo-emulsions and some accessory photographic phenomena. Raymond Chastel and Pierre Süe. Science et inds. phot. 20, 81-4(1949) Mar. (in French).

Various methods were applied for obtaining tracks of $\beta$-rays in emulsions rich in silver of the type Ilford "Nuclear Research." Experiments with fine needles showed the abrasion effect. In several cases clusters of silver grains were observed on the surface of the emulsion adjoining the glass. Individual $\beta$-ray trajectories were obtained by using special emulsions of the type Eastman-Kodak "NTB." The tracks so obtained are the end portions of the electrons' trajectories, corresponding to the last few Mev of their energy. However, the plates which the authors had at their disposal could not be used in any quantitative work. A slight improvement of these emulsions is still to be desired.

435 Determination of radioactive carbon. Locke White, Jr. Isotopes Division Circular IDA-2 (Southern Research Institute). Nov., 1947. 7p.

This communication describes the apparatus used to measure the specific activity of $C^{14}$ in barium carbonate samples obtained by oxidation of the tissues of mice injected with radioactive urethane. The carbon is counted as carbon dioxide inside the counter tube, by a slight variation of the method of Miller (Science 105, 123(1947)). The apparatus is diagrammed schematically. Essentially the procedure involves the liberation of carbon dioxide from the barium carbonate by addition of perchloric acid, the removal of water by condensation at about −80°C, the collection of the carbon dioxide by condensation at about −195°C, the volumetric measurement of the quantity of carbon dioxide, the addition of a predetermined quantity of carbon disulfide, the condensation of the resulting mixture in the Geiger-Müller tube, the thorough mixing of the gases after evaporation, and measurement of the counting rate.

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436 Effects of the pH on the development of photographic plates saturated with borax or uranyl nitrate. E. Picciotto. Compt. rend. 228, 247-8(1949) Jan. 17 (in French).

Experiments are described which indicate that the unsatisfactory nature of previous results obtained using borax and uranyl nitrate loaded photographic plates may be attributed to pH effects; a means of overcoming this difficulty is suggested. It was found that a boron-loaded plate developed in a solution at pH 6.3 gave a satisfactory record of the tracks produced by $\alpha$-particles and it is suggested that the best way to introduce boron into the plate is to impregnate it with a solution of borate and boric acid adjusted to the pH of the ordinary emulsion. This result is in agreement with the theory advanced by Dilworth and Occhialini (private communication, Jan., 1948) to explain the unsatisfactory results sometimes obtained using boron-loaded plates saturated with borax of pH 9.0 (Dilworth, et al, Nature 162, 102(1948); Lattes, et al, Nature 160, 458(1947)). Similarly, the desensitization attributed to uranyl nitrate (Picciotto, Compt. rend. 228, 174(1949); Tsien, et al, J. phys. radium 8, 6(1947)) making development impossible, is also shown to be attributable to a pH effect and it is suggested that the adjustment of the pH of the solution to approximately 7.0 will result in complete and homogenous development. It is noted that the curves giving the plate concentration of uranium as a function of the external solution uranium concentration indicates the effect of the variation in pH on the absorption of the solution as well as the influence of the external concentration on the quantity of uranium absorbed (Haenny and Rochat, Helv. Phys. Acta 21, 186(1948); Broda, Nature 4059, 231(1947)).

437 The energy dependence of several organic and inorganic phosphors in scintillation counters. R. H. Davis and J. D. Graves. Naval Radiological Defense Laboratory Report No. ADP-119, May 2, 1949. 5p.

The energy dependence of naphthalene, anthracene, stilbene, calcium tungstate, thallium-activated potassium iodide, potassium bromide, and 1P21 phototube as used in scintillation radiation detectors has been determined with x-rays in the energy ranges from 30 to 185 effective kv and for radium gamma radiation.

438 Excitation of phosphors by high-energy products of uranium. I. Broser and H. Kallman. Ann. Physik 4, 85-9(1948) Sept. (in German).

Scintillations produced by single strongly charged high-energy particles formed during the uranium fission were studied with the aid of a "scintillation mass-counter" (consisting of a screen of scintillating material and a secondary electron multiplier). Even in the presence of an intensive $\gamma$-radiation, heavy nuclear fission products were easily detected by this method. In several ways it was proved that the observed strong scintillations were due to the uranium fission products. Measurements were also made of the absolute energy yields and of the duration of scintillations produced in ZnS-Ag by single heavy charged nuclei.

439 Experiments in the possibility of increasing the efficiency of gamma-counters. Hilding Slâtis. Rev. Sci. Instruments 20, 353-4(1949) May.

The efficiency of Geiger-Müller tubes for recording $\gamma$-quanta is increased by insertion of concentric ring systems of metal between the wire and the cylinder. When the ring systems are given suitable voltages, good plateaus and resolving times are obtained. The efficiency of a counter, which has 3 ring systems with 24 rings in each system, is 2.5 to 3.5 times that of a conventional counter of the same size. This means an increase of 6 times in $\gamma$-$\gamma$ coincidence measurements.

440 Gasket for mica windows. E. J. Harris. J. Sci. Instruments 26, 205(1949) June (Laboratory and workshop notes).

It has been found that coated patching-rubber is suitable for use as a gasket material for obtaining a seal between the mica and the metal (after treatment with a dilute solution of neoprene in benzene) of bell-type thin-window (mica) Geiger counters.

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441 Geiger counter technique. Herbert Friedman and H. F. Kaiser. Naval Research Laboratory Report NRL-M-1800, Jan. 1, 1942. 74p.

An investigation of the possibilities of utilizing Geiger-Müller counters for rapid inspection with penetrating radiations has been undertaken. Preliminary results, reported in NRL Report M-1799, indicate that the counter, even in its simplest form is sufficiently sensitive to make its use more advantageous than the usual photographic techniques in many cases. The opening section of this report is, therefore, devoted to a theoretical analysis of the counting process. The next sections are concerned with the construction and preparation of counters, and the methods of obtaining high resolution and high sensitivity. The final section of the report describes the most important circuits for counting and the conditions under which they are to be employed. 35 references.

442 Instruments for measuring radioactivity. C. J. Borkowski. Analyt. Chem. 21, 348-52(1949) Mar.

The characteristics and applications of some of the instruments used to measure radioactivity are reviewed. The following types of instruments are considered: (1) Geiger-Müller counters, (2) $\beta$-proportional counters, (3) integrating-type ionization chambers, and (4) scintillation crystal detectors.

443 An internal geiger counter for the assay of low specific activity samples of $C^{14}$ and other weak beta emitters in biological samples. F. E. Kelsey. Science 109, 566-7(1949) June 3.

A procedure permitting statistically valid analyses of samples employed in the measurement of isotopic compounds used for biological investigations is presented. This procedure requires 1/5, or less, the activity of the sample necessary for a successful measurement by the mica-window tube method. The windowless Geiger tube of this continuous gas flow type, utilizing a mixture of helium and alcohol vapor as the counting gas, permits the counting of all particles escaping from the sample. The structure of the counter is presented in 2 figures. The activity of tissues, blood, urine, and solutions or suspensions of watersoluble or insoluble substances, may be measured.

444 Luminous bacteria as a possible radiation dosimeter. J. P. Dyson. Naval Radiological Defense Laboratory Report ADH-79, Mar. 9, 1949. 23p.

The primary purpose of this experiment was to determine whether luminescent bacteria could be used as indicators of either the dose-rate or the total dose for x or gamma-radiation. Such a biological indicator of radiation, if properly employed, probably would lend itself more readily to describing the effects of radiation on other living organisms (e.g., man, animals, etc.) than would the present methods of measuring the dose of radiation received. A program was set up and followed which embraced the following: (1) determination of the growth requirements; (2) staining and counting techniques; (3) effect of x-rays on the luminescence of dilute and concentrated bacterial suspensions. After these initial investigations had been carried out, it was decided that a more thorough program should be developed; hence the following features were included in the study; (4) effect of x-rays on the ultraviolet absorption spectra of both cultures and suspensions of luminous bacteria; and (5) the effect of photosensitizing dyes on the reaction of the bacteria to x-rays. Although the bacteria failed to show any response to x-irradiation in the principle range of interest (i.e., 0 to 2000 r), experimental procedures and results are given so that if further studies of the effect of x-irradiation on the enzyme systems of these bacteria are carried out, the data given in this report will be of some value. 26 references.

445 A modified lauritsen electroscope for the measurement of $C^{14}$ activities. R. F. Hunter and W. B. Mann. National Research Council of Canada Report CRM-409, nd. 4p.

The instrument described is for use with solid carbonate deposits on aluminium trays. The modification which has to be made for this purpose consists essentially in removing the aluminium

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can from the electroscope and substituting one which operates in such a manner that the aluminium tray on which the sample is deposited can be inserted into the ionization chamber without opening this to the air. This has been achieved by using a simple sliding mechanism, the general construction of which is illustrated. The functioning of the modified electroscope was tested using two sources of $C^{14}$ prepared by pipetting about 0.010 and 0.020 ml of standard sodium carbonate solution on to two aluminium planchettes and evaporating the solution. The ratio of the activities was then determined by means of the electroscope, taking readings over 10 scale and 40 scale divisions for each sample. A series of observations was made and the probable error for a single observation was calculated. A typical set of readings and a discussion of the results are given.

446 A negative feed-back dosage-rate meter. R. J. Herbert. Brit. J. Radiology 21, 420-4(1948) Aug.

A direct reading x-ray dosage-rate meter is described, which consists of a radiation-transparent thimble ionization chamber (volume 1/2 cc), connected by a thin flexible cable to a negative feed-back d-c amplifier. The instrument is robust and cheap to manufacture. An accuracy of better than ±5% or 1 r/min is achieved on all ranges, and the instrument is intended for routine measurements in a radiotherapy department. Standard radio components are used throughout and electrometer valves have been eliminated. The instrument is adaptable for radium dosage-rate measurements, stray radiation measurements, and as a radon balance.

447 A new photographic technique in nuclear physics. J. A. Teegan. Beama J. 56, 31-7(1949) Jan.

The photographic-emulsion method of recording the passage of charged nuclear particles is discussed and compared with the cloud chamber method. The identification of particles from their tracks is treated and several typical track emulsion photographs which are shown are discussed. Tracks illustrating (1) the scattering of particles by light and heavy nuclei, (2) the production of an artificial transmutation, (3) fission, (4) cosmic rays, and (5) mesons are included.

448 A new type of focusing in a magnetic lens field. Hilding Slätis and Kai Siegbahn. Phys. Rev. 75, 1955(1949) June 15 (Letter to the editor).

A $\beta$-lens spectrometer is described which employs a new focusing principle. The magnetic gradient in the spectrometer is made sufficiently strong (the magnetic field having a minimum halfway between source and counter) and a first or intermediate ring-formed "image" of the source is obtained midway between source and detector. A ring-formed shutter is placed there, which transmits the beam and a second point image is formed at the G-M slit. It is found that quite a substantial solid angle of the total radiation can be utilized at a good resolving power. Thus at a resolving power of 4% a transmission of ~8% can be obtained. Diagrams and curves indicating the method of adjustment of the magnetic gradient for a given radius of the central shutter are given. It is noted that, owing to the strong dependence of the counting rate on the source position, scattered radiation from other places does not contribute to the counting.

449 A note on a self-sealing insulator for a high pressure ionization chamber. J. Read. Brit. J. Radiology 21, 425-6(1948) Aug.

An insulator for the central electrode of a nitrogen-filled ionization chamber (at 60 atmospheres) which is self-sealing at the pressure used, thus eliminating the necessity of using a sealing compound, is described. The new insulator was made of Alkathene, and is more plastic than the amber insulator it replaces. The assembly is shown in a diagrammatic form and tabulated data are given which illustrate the satisfactory performance of the device.

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450 Observations on the ionization produced by high-voltage radiation in moulded ionization chambers with walls of various effective atomic numbers. Samira M. Aly and C. W. Wilson. Brit. J. Radiology 22, 243-54(1949) May.

An account is given of some experimental and theoretical observations on the ratio of ionizations in pairs of chambers one of which was "air-walled" while the other had a higher effective atomic number. The observations were made over a range of wavelengths from that of radium $\gamma$-rays (0.013A) to 0.50A. The ionization chambers were moulded from powered mixtures of bakelite, graphite, and either vanadium oxide or cerium oxide; the amount of metallic oxide served to adjust the effective atomic number of the wall material and in addition to "air-wall" chambers, others having effective atomic numbers Z equal to 12.84, 17.04, and 20.84 were used. It was found that such chambers could be reproduced satisfactorily and that the materials were adequate electrical conductors. Measurements of the ionization ratios were made with a Kemp type dose-meter and calculations of the same quantities were based on the Bragg-Gray theory, suitable allowance being made for absorption of radiation in the chamber walls. The experimental values show that the "chamber pair method" may be used to determine radiation wavelengths shorter than 0.19A and that it is desirable that the non "air-walled" chamber of the pair have the highest practicable Z in order to obtain maximum sensitivity. The measured and calculated ratio values agree up to a wavelength of about 0.08A, but at longer wavelengths there is a systematic divergence between the values which is related to the wavelength of radiation and effective atomic number of the non "air-wall" material. A semi-empirical modification of the Bragg-Gray theory is proposed in order to explain these results. This suggests that they are due to variation in the amount of ionization contributed by the photo-electrons from the chamber wall with variation in the energy (i.e., range in air) of these electrons. For photo-electron energies greater than about 170 kev (i.e., range in air greater than 66 cm.) the contribution to the ionization by the photo-electrons appears to be complete; below this energy the contribution diminishes regularly with photo-electron energy. 14 figures. 19 references.

451 Octane vapor proportional counter. T. P. Pepper. Rev. Sci. Instruments 20, 222-3(1949) Mar. (Laboratory and shop notes).

Chemically pure n-octane vapor at room temperature has been used in a proportional counter for the study of the relative yields of the concurrent nuclear reactions: D(d,p)T, and D(d,n)$He^3$. An octane-filled counter behaved as expected by giving a pulse distribution similar to that of a methane-filled counter at roughly six times the pressure. A representative pulse distribution as recorded on a 30-channel pulse analyzer is given. This preliminary success suggests using the saturated vapor of organic compounds of large molecular stopping-power for filling proportional counters. Two useful properties peculiar to such counter fillings are the following: (1) They present molecular stopping power at least equal to the heaviest gases normally used. This aids experiments requiring low pressure fillings containing one or other of the hydrogen isotopes. (2) The pressure, hence stopping-power, of the counter filling is a function of the temperature alone. This would permit thermostatic control of the counter. The likelihood that such counters would probably be long-lived is noted and selected organic compounds of large molecular stopping power which might be suitable for use as fillers are tabulated.

452 Parallel-plate counters. J. Warren Keuffel. Rev. Sci. Instruments 20, 202-8 (1949) Mar.

The counter characteristics of a discharge tube using plane-parallel electrodes have been investigated, particularly with regard to the short time lags inherent in the streamer type of spark which occur with such a geometry at near-atmospheric pressure. Construction details for parallel-plate counters with good counter characteristics are given. Spurious counts were minimized by an argon xylene filling mixture and the use of a univibrator quench circuit. The uncertainty in the reaction time of the counters is $\pm 5 \times 10^{-9}$ sec.

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453 Photomicrography of tracks in nuclear research emulsions. Adair Morrison and Fred Morton. Rev. Sci. Instruments 20, 341-2(1949) May.

A simple projection system and film holder for taking photomicrographs of particle tracks in photographic emulsions of the type used for nuclear research is described. With this film holder a series of exposures covering a considerable length of the track image is obtained on a single film as adjacent segments of track are brought successively into sharp focus and recorded. The film holder was designed to expose only a few millimeters at a time of a strip of film aligned with the track. It consisted of two pieces of black Bakelite, with the film between them clamped together with thumb screws. The upper piece had a rectangular opening cut through it directly above the film; this opening could be partly or completely closed by two white slides traveling just above the surface of the film. These traveled in a channel cut into the lower face of the upper Bakelite piece from one end to the other. The dimensions and details of construction are shown. The particular advantages of this method are: (1) a special microphotographic camera is not required; and (2) long tracks can be photographed quickly on a few films; this reduces both the cost, and the time spent in printing, processing, and constructing a mosaic.

454 The production of end-window Geiger-Müller beta counters. R. C. Hawkins, F. N. MacGillivray, and W. B. Mann. National Research Council of Canada Report CRM-411, nd. 8p.

The design chosen for these counters was essentially the same as those in general use with a number of modifications. The counters were constructed from copper tubing of 1 1/32-inch internal diameter and of varying length. After experimenting with a number of different lengths, two lengths were adopted for general construction, namely 1 3/4 inches. The construction of the 1 3/4-inch long counter is discussed in detail, and the parts of a counter prior to assembly of the window are illustrated.

455 A pulse amplitude analyzer for nuclear research using pretreated pulses. C. H. Westcott and G. C. Hanna. Rev. Sci. Instruments 20, 181-9(1949) Mar.

A pulse analyzer is described by means of which simultaneous records may be obtained from 30 channels, the upper amplitude limit for any channel being the lower amplitude limit of the next. The equipment described can be used to obtain detailed information on the frequency of occurrence of ionization pulses of various amplitudes when used in conjunction with an ionization chamber and a linear amplifier of suitable design. This apparatus has been designed to deal with relatively fast counting rates and with pulses having a wide variety of shapes and durations. In order to avoid having to change the circuits of each of the 30 channel units to suit the pulse shape, the pulses are "pretreated" to yield signals of standard form before being passed to the channels for analysis. Ease of calibration and monitoring are further advantages of the new analyzer. The console containing the apparatus is of reasonable mobility and convenient in shape. Interchangeable plug-in channel units are employed.

456 Quantitative measurements on $\alpha$-particles with the scintillation mass-counter. I. Broser and H. Kallmann. Ann. Physik 4, 61-8(1948) Sept. (In German).

The transformation of the kinetic energy of $\alpha$-particles into light was quantitatively studied on scintillations produced by $\alpha$-particles in layers of powdered ZnS-Ag. The instrument used was a "scintillation mass-counter" comprising the scintillating substance and a secondary electron-multiplying photo-cell. Effects produced both by single $\alpha$-particles and by numerous particles were observed, and a method was developed for the determination of the energy of $\alpha$-emitting preparations. The counting of scintillations with the simultaneous measurement of the light intensity showed that single $\alpha$-particles of equal energy produce scintillations varying widely around an average value. Considerably better results were obtained by using one large crystal of cadmium sulfide; in this case the deviations do not exceed $\pm 25\%$. By the last method, single $\alpha$-particles of only 100,000 volt energy can be recorded and measured. It follows from direct-current measurements with numerous $\alpha$-particles that, in the case of ZnS-Ag, the physical yield of the transformation into light is almost independent from the particle's energy, at least in the range 0.1-5 Mev. Additional 100 particles/sec are easily detected by the appearance of a $10^{-9}$ amp current in the amplifier. A method is thus found which permits the gauging of $\alpha$-activities of all intensities.

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457 The RCA 1P21 photomultiplier tube as a gamma ray detector. J. D. Graves and G. E. Koch. Naval Radiological Defense Laboratory Report No. ADP-105, Apr. 13, 1949. 20p.

The characteristics of the 1P21 photomultiplier tubes used as a gamma radiation detector have been studied. The response of the tube has been determined by metering the total current output. The range of radium gamma radiation intensities observed has been from 0.001 to 100 r/hr. The response of the tube was linear throughout this range. The tube exhibited no directional dependence in the plane perpendicular to its axis. In the plane containing the axis of the tube a 28% variation in response was observed for a point source 40 cm from the tube. Minimum response occurred for the gamma source on the axis of the tube. A 0.6% per degree centigrade decrease in response was observed with increasing temperatures in the region of room temperature. A 1% increase in applied voltage resulted in a 10% increase in response.

458 References pertaining to measurement of soft beta rays. Isotopes Division Circular IDA-1, Mar., 1948. 3p.

A bibliography consisting of 28 references.

459 Relays used in counters and recording cup anemometers. J. L. French and G. M. Lane. J. Sci. Instruments 26, 160(1949) May.

An improved method for obtaining a scale-of-two counter, as compared with that described by Taylor and French (J. Sci. Instruments 25, 283(1948) Aug), is described. In addition, another circuit is shown which can be easily altered to give a scale-of-ten counter, too. The maximum counting speed claimed for this device is 100 pulses/sec.

460 The scintillation counter. J. W. Coltman. Proc. I. R. E. 37, 671-82(1949) June.

Present knowledge of the scintillation counter and the details of its operation are reviewed. Following a general theoretical discussion of the mode of operation the following topics are considered in their relationship to scintillation counters: (1) photomultiplier tubes, (2) phosphors, (3) optical systems, (4) associated electronic circuits, and (5) the derivation of optimal circuit constants. The performance of the scintillation counter is evaluated and compared with that of other detectors. Results reported by various investigators indicate that high efficiencies can be obtained for a wide variety of radiations using this type of detector. It is noted that the fact that the radiation is absorbed in a solid is perhaps the most promising feature of the scintillation counter, since future particles and radiations to be produced artificially will probably be increasingly energetic and penetrating. 18 references. 18 figures.

461 A simplified chronotron-type timing circuit. J. Warren Keuffel Rev. Sci. Instruments 20, 197-201(1949) Mar.

A timing circuit is described similar in principle to the Neddermeyer "chronotron" (Rev. Sci. Instruments 20, 688(1947)), but with the following simplifications and modifications: (1) a parallel-wire polythene-taps line to eliminate the necessity for numerous cumbersome tubes, (2) germanium crystal detectors, and (3) a delay-line presentation circuit. This circuit uses a single common amplifier for all pulses, which increases stability, makes adjustment easy, and effects a tenfold saving in the number of tubes. It simultaneously records time intervals in two ranges, e.g,, 0-0.1 and 0-5 $\mu$ sec. The precision is $1 \times 10^{-9}$ sec., but may be increased at the expense of the range. Problems connected with coupling the instrument to parallel-plate counters are discussed.

462 Simplified ionization chamber. Isotopes Division Circular IDC-7, Apr. 20, 1949. 6p.

The construction and operation of a simplified ionization chamber for gamma ray measurement are described. Scaled diagrams are included. The report is a reproduction of the paper "Chicago Pressure Ionization Chamber for Gamma Ray Measurement" by F. R. Shonka and R. J. Stephenson.

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463 Special sample tray for the continuous gas-flow type counter tube. G. E. Burch, J. A. Cronvich, T. Ray, P. B. Reaser, and S. A. Threefoot. Science 109, 516(1949) May 20.

An improved sample tray for use in the continuous gas-flow type of counter tube is described which makes it possible to reduce the length of time required to flush the counting chamber with gas. The improved tray consists of a circular metal disk containing three receptacles for samples. The latter are symmetrically arranged so that while one is in the counting space, the second is in the preflush position, and the third is open to the atmosphere for sample changing. Rotation of the disk, to allow a change in position of the sample, has been provided for. The construction details of the design are indicated in several drawings.

464 A study of background rate in Geiger-Müller counters. J. L. Putman. J. Sci. Instruments 26, 198-201(1949) June.

A series of experiments is described in which the background counting rate of $\gamma$-ray counters is reduced by screening them in lead to attenuate local $\gamma$-radiation and by surrounding them with cosmic ray counters in anti-coincidence to reduce the counting rate due to mesons. The normal background is reduced by these means by a factor of from 13 to 17 without impairing the efficiency for $\gamma$-rays. A residual background rate of about 1/20 the normal rate is left unexplained. This is believed to be due to secondary $\gamma$-rays produced in the walls of the lead castle by decaying mesons.

465 The temperature dependence of a scintillation counter using several organic and inorganic phosphors. J. D. Graves and G. E. Koch. Naval Radiological Defense Laboratory Report ADP-84, Mar. 22, 1949. 23p.

The dependence upon temperature of the response of gamma scintillation counters has been studied using naphthalene, anthracene, stilbene, calcium tungstate, thallium-activated potassium iodide, and thallium-activated potassium bromide as the luminescent material in the range from −196°C to +40°C. Temperature dependence was observed in all cases. Irreproducibility prevents any general definition of the temperature dependence to the counter using the organic crystals. Reproducibility of results was observed using the inorganic phosphors over a period of a month. The limitations imposed on counting applications by these temperature effects and irreproducibilities are discussed.

466 A theory of the solenoid $\beta$-ray spectrometer. E. Persico. Rev. Sci. Instruments 20, 191-6(1949) Mar.

A theory of the magnetic lens $\beta$-ray spectrometer utilizing the uniform field of a long solenoid is developed. First the case of a point source is considered, and it is found that the resolving power, for a given solid angle, is maximum when the emission angle $\alpha$ (average angle between the rays leaving the source and the axis) is 45° 37′. Then the theory is extended to the case of a disk source, and it is found that for a given intensity (product of the source area by the solid angle) there is an optimum source diameter and an optimum emission angle, ranging in practical cases between 36° and 40°. The problem of optimum conditions when the quantity of copper in the solenoid and the electric power available are limited by economical considerations is also studied, and it is found that the optimum $\alpha$-value is in this case about 21°.

467 Working instruction manual for scaling unit type 200 and 200A. Atomic Energy Research Establishment, Great Britain, nd. 47p. (NP-838).

The scaling unit is designed to count and register the number of pulses arriving in a random manner over a period of time. The design consists of two electronic scales of ten with neon indicators followed by a mechanical counter of four digits. In this way a six-figure number can be registered. The mechanical counter is a post office telephone call meter and is capable of operating at five pulses per second. The electronic scaling circuits will operate from pulses spaced by five microseconds or more.

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468 The Bose-Einstein statistics of particles, with special reference to the case of low temperatures. R. B. Dingle. Proc. Cambridge Phil. Soc. 45, 275-87(1949) Apr.

The author attempts to show that all the demonstrations of the phenomenon of Bose-Einstein condensation (in an ideal gas) previously given in the literature are invalid due to the lack of convergence in the series derived from the method of steepest descents. To replace these invalid demonstrations a method is developed for obtaining exact formal expressions for the partition functions and the mean occupation numbers of classical and Bose statistics, and also the exact theory of fluctuations in Bose statistics. The theory of the method of mean values is discussed; it is first assumed that all accessible states of the system under consideration are non-degenerate and the Bose-Einstein distribution function for a non-degenerate system is treated. Finally, the degenerate cases are considered. (Suitable working approximations to these formal solutions will be given in a subsequent paper.)

470 An iterative method for finding the smallest eigenvalue of a matrix. John B. Lohman. Quart. App. Math. 7, 234(1949) July (Notes)

A modified procedure for an iterative method of obtaining the smallest eigenvalue of a matrix A is described which leads to more rapid convergence. The eigenvalues and eigenvectors of a matrix A are often found by repeated premultiplication of an arbitrary column vector v by the matrix A. The products $A^n v$ converge to the eigenvector $v_1$ corresponding to the eigenvalue $\lambda_1$ largest in absolute magnitude; convergence is rapid if $\lambda_1$ is much larger than any other eigenvalue of A. If approximate values of the eigenvalues of A are known this interative method can be modified to give more rapid convergence.

471 Magnetic polarizability of the electron. S. N. Gupta. Nature 163, 686-7(1949) Apr. 30.

A recent simple derivation obtained by Luttinger (Phys. Rev. 74, 893(1948)) of the radiative correction for the magnetic moment of the electron has been extended to obtain the magnetic polarizability of the electron by carrying the expansion in H (the constant magnetic field) further. It is found that this term is convergent for large values of the momentum of the virtual photons but diverges logarithmically for low values. The following expressions have been obtained for the contributions to the self-energy of the electron due to the static and dynamic interactions with the virtual photons:

$$E_{static} = -\frac{e^4H^2}{90\pi m^3} + O(H^3)$$

$$E_{dynamic} = -\frac{e^4H^2}{4\pi m^3} - \frac{2e^4H^2}{3\pi m^3} \log \frac{2eH}{m^2} + O(H^3)$$

It is noted that the polarizability is too small to be observed at present.

472 Note on Dirac's theory of magnetic poles. M. N. Saha. Phys. Rev. 75, 1968(1949) June 15. (Letter to the editor).

It is noted that the method described by Wilson for determining the value of Dirac's free magnetic poles (Phys. Rev. 75, 308(1949)) has been previously described by the author. (Ind. J. Phys. 10, 145(1936)).

473 Note on the iterative method in nuclear problems. R. McWeeny. Proc. Cambridge Phil. Soc. 45, 315-7(1949) Apr. (Research note).

The iterative technique (developed by Svartholm) as applied to the treatment of the two-, three-, and four-body problems (assuming Gaussian interactions), has been improved by a simple modification of the initial function. Since the first approximation to the wave function is in essence a product-function of appropriate symmetry based on the deuteron function, the two-body case is first examined

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to obtain the most suitable analytical form. The initial expression for the many-body problem is then extended in an essentially similar manner. It is noted that a significant improvement of the initial function is highly desirable on account of the completely false nature of the simple Gaussian type employed by Svartholm; the important point is that this improvement is best secured by adding a particular non-orthogonal set rather than by adding symmetrized oscillator functions. The latter method is very slowly convergent due to the asymptotic behavior of the Gaussian function; this cannot be corrected substantially by adding members of the same function system.

474 On the analysis of the Lorentz group in algebraic representation. S. C. Kar. Bull. Calcutta math. soc. 40, 163-72(1948) Dec. (in German).

A new derivation is presented of Einstein's theorem on the decomposition of the Lorentz group (Einstein and Mayer, Semi-Vektoren und Spinoren, Sitzber. preuss. Akad. Wiss. Physik. Math. Klasse, 522(1932)). The investigation proceeds algebraically and has, therefore, the advantage of greater clearness. Furthermore, an algebraic representation is given of the Lorentz group, which is made particularly simple by the exclusive use of Pauli's matrices.

475 On the self-energies and cross-sections of orthodox quantum mechanics. H. S. Green. Proc. Roy. Soc. (London) 197A, 73-89(1949) May 11.

Several new techniques are introduced with the objectives of: (1) the gaining a new understanding of the divergence difficulties of orthodox quantum theory, and (2) systematically developing the quantum mechanics of fields in terms of the density matrix. A new presentation of a form of perturbation theory is included which has the following advantages over the usual theory: (1) it converges much more rapidly, and (2) the density matrix is normalized at every stage so that the diagonal elements representing occupational probabilities cannot diverge. Exact general formulas are derived for self-energies and cross-sections for the purpose of the examination of convergence properties. The general theory of fields is developed and it is shown that the use of the density matrix in place of the wave vector illuminates and simplifies the customary theory. The second quantization of the density matrix facilitates an understanding of the existence of particles with negative expectation values. Finally, the whole theory is applied to the example of the electron or positron in an electromagnetic field. It is confirmed that the self-energy of the electron in the orthodox theory cannot be made finite without the introduction of negative energy photons.

476 On the wave equation with small quantum numbers. Rudolph E. Langer. Phys. Rev. 75, 1573-8(1949) May 15.

A means of applying the asymptotic method in the determination of the eigenvalues and the normalization of the eigenfunctions of the one-dimensional wave equation, in which the potential energy has a single minimum, for small quantum numbers is considered. Customarily the use of the phase integral and the asymptotic W.K.B. formulas lead to results which are established only for sufficiently large quantum numbers. For the case of the eigenvalues, the characteristic equation appropriate to the lower range is derived, and a comparison of the new equation with the familiar one based on the phase integral is made. By this method it has been established that under certain liberal conditions on the potential energy the older method gives a good approximation. It is noted that in the special case of the harmonic oscillator the two equations are identical. A method similar to that used by Furry (Phys. Rev. 71, 360(1947)) has been applied to the normalization of the eigenfunctions. Formulas for the normalized eigenfunctions are given over the several intervals of the variable and over the critical interval which includes the minimum of the potential energy and the turning points, as well as over the intervals remote from the turning points.

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477 On the wave mechanics of the electron. Florent Bureau. Compt. Rend. 228, 465-7(1949) Feb. 7 (in French).

Wave-mechanical expressions for the electron have been evaluated systematically by a symbolic method, using some analogies with analytical mechanics and considering only real quantities. To facilitate the study of the rotations of the relativistic transformation the resulting equations are written in the usual Dirac form. The problem of Cauchy is found to result from the relativistic change, i.e., from the point of view of the observer there is an important difference between the relativistic and non-relativistic expressions, thus, while the Huygens principle is valid for the latter it is not valid for the relativistic form. The physical significance of this discrepancy is discussed and it is concluded that this is the source of the diverse difficulties encountered in the wave-mechanical interpretation of the electron.

478 Polarization of the vacuu. Jerzy Rayski. Phys. Rev. 75, 1961-2(1949) June 15. (Letter to the editor).

The discrepancies in the results obtained by Heisenberg (Z. Physik 90, 209(1934)), Wentzel (Phys. Rev. 74, 1070(1948)), and Schwinger (Phys. Rev. 75, 651(1949)) on the problem of the vacuum polarization and the related question of the self-energy of the photon are considered. The disagreement is attributed to the assumption (in the proofs of the gauge invariance of the formalism) that the Schrödinger equation possesses a solution; however, this is not true in frames of the quantized field theory, or at least in the case of two coupled fields. It is also noted that the basic expressions for the vacuum polarization are mathematically meaningless at the light cone so that by formal operations on non-existing integrals one may obtain any result desired. A special regularizing procedure, which is necessary to give mathematical meaning to such expressions, is outlined. This procedure secures the consistency of the calculations but means a departure from the wave equation. Another possibility, which seems promising, is to combine several charged fields with different transformation characters of their field functions. It is noted that the conditions for compensation show a remarkable analogy with the conditions for regularization and may be considered as conditions for the existence of a solution of the Schrödinger equation.

479 A property of the Yukawa potential. I. N. Sneddon and C. K. Thornhill. Proc. Cambridge Phil. Soc. 45, 318-20(1949) Apr. (Research note).

An equation has been derived which gives the form of the potential v(r) between two unit-point masses which leads to a mutual energy of the form m(a)m(b)v(R) for two spheres of radii a and b whose centers are a distance R(>a+b) apart. An examination of the possible solutions of this equation shows that the Yukawa potential (and as a special case, $\lambda = 0$, the Newtonian potential) is the only one for which the two spheres behave as though equivalent masses m(a) and m(b) were concentrated at the centers of the spheres. (Recently Bouwkamp Physica 13, 501(1947)), has shown that if the potential between two unit-point masses is the Yukawa potential $e^{-\lambda r}/r$, then the mutual energy of two spheres of constant density $\rho$ whose centers are a distance R apart is proportional to $e^{-\lambda R}/R$. It is found that with this law of attraction a sphere of radius a behaves as though a mass

$$\frac{4\pi a\rho}{\lambda^2}\left(\cosh \lambda a - \frac{\sinh \lambda a}{\lambda a}\right)$$

is concentrated at its center.)

480 The quantum-mechanical problem of a particle in two adjacent potential minima II. Solution by perturbation theory methods. D. S. Carter and G. M. Volkoff. Am. J. Phys. 17, 303-10(1949) May (See Nuclear Science Abstract 2-2189).

The usual Schrödinger perturbation theory is applied to the problem of determining the effect which the presence of a shallow potential well has on the levels of a neighboring potential well. An exact solution in implicit form was obtained and reduced to the explicit form in three special cases

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in Part I (Amer. J. Phys. 17, 187(1949)). Both the $\epsilon$ -type perturbation theory and the $\lambda$-type perturbation theory are considered for the two-well problem. The results obtained are discussed and as an example, the simple model of two neighboring identical rectangular wells is used to illustrate the origin of the inversion spectrum of ammonia, and the method of obtaining some constants of the ammonia molecule from this spectrum.

481 Quantum-theory restrictions on the general theory of relativity. M. F. M. Osborne. Phys. Rev. 75, 1579-84(1949) May 15.

The limitations set by the uncertainty principle on the measurement of the curvature of space are determined by passing a small test particle around a geodesic triangle. In measuring the curvature of space around a Schwarzschild-solution particle of finite size and physicallly realized density, it is found that the mass must be at least of the order of $10^4$ kgs, or the curvatures cannot be measured with an accuracy equal to the order of magnitude of the terms in the defining equations $G_{ik} = 0$. For mass points, the lower limit is $10^{-5}$ g. For smaller masses, the curvatures can only be measured with less accuracy and only over large regions of space. Similar limitations apply to alternative laws of gravitation involving higher derivatives of the metric. It is concluded that in any theory which attempts to unite quantum theory with the general theory of relativity, the relation of the metric to the energy momentum tensor, $G_{ik} - g_{ik}G/2 = -KT_{ik}$, must appear only in the large and in a statistical sense, i.e., for large regions of space and large numbers of elementary particles.

482 The relativistic quantum mechanics of the elementary particles. H. S. Green. Proc. Cambridge Phil. Soc. 45, 263-74(1949) Apr.

An attempt has been made to resolve the dilemma created by the large number of dimensions of the representations of the spin operators, which makes the matrix expressions almost useless for practical purposes. In order to do this, a kind of symbolic representation commonly used in group theory (Theory of Groups and Quantum Mechanics by Weyl. London, 1931) which requires only non-commutative algebra, has been developed. Simple illustrations of the method are given for the Pauli spin operators and the Dirac operators, in which the corresponding irreducible two-dimensional and four-dimensional ring representations are obtained, respectively. The relativistic density matrix is considered and it is postulated that the Hamiltonian energy and the total angular mementum, properly defined, commute with one another. The relationship between the eigenvalues obtained and the properties of the particle are discussed and the means of writing the density matrices corresponding to particles of known energy and momentum is described. This is extended so that the properties of the more general types, corresponding to statistical distributions of particles with different energies, momenta, and rest-masses can be evaluated. Finally, the corresponding sets of idempotents for spin values are obtained for the meson and proton. A comparison of the expressions obtained is found to provide a possible distinction between the "permanent" particles like the electron, proton, and neutron, and the "interaction" particles like the photon and meson.

483 Spin of the vector meson. J. A. Balseiro. Pub. facultad cien. fis.-mat. univ. nac. (La Plata) No. 195, 125-40(1948) (in Spanish).

A relativistically invariant definition of a spin operator can be obtained after the total angular momentum of the vector meson field has been split into an orbital momentum and a spin momentum. This is accomplished and the spin matrices are obtained from two submatrices which (as in the case of Dirac's electron) can be interpreted as corresponding to mesons of charge +e and −e, respectively. It is noted that in a non-relativistic approximation, the eigenfunctions of total angular momentum for free mesons can be considered as a generalization of the eigenfunctions obtained by Pauli in a (non-relativistic approximation) for the total angular momentum of the electron. (Information taken from Science Abstracts 52, Sec. A 163-4(1949) Apr.

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484 Symmetrical meson theory of nuclear forces. Ta-You Wu and H. M. Foley. Phys. Rev. 75, 1681-6(1949) June 1.

The static and the first order non-static nucleon potential on the basis of the Møller-Rosenfeld-Schwinger (Kgl. Danske Videnskab. Selskab, Skrifter, Naturvidenskab. math. Afdel. 17, No. 8 (1940); 23, No. 13(1945); Phys. Rev. 61, 287(1942)) mixture of a vector meson of mass $k_0$ and a pseudoscalar meson of mass 315 $m_e$ is assumed. A relationship between the coupling constants is postulated to remove the inadmissable singularities in the tensor force term. The coupling constants are then determined by means of the binding energy of the deuteron and the total cross section for slow neutron scattering. The potentials so determined are used to calculate the "effective range" $r_0$ for the triplet and the singlet states (proton-proton scattering), the quadrupole moment Q of the deuteron, and the cross section $\sigma$ and $\sigma(170°)/\sigma(90°)$ for proton-neutron scattering at 100 Mev. The value $K_0 = 1.5 \times 315\ m_e$, while giving somewhat too low values for the $r_0$'s yields entirely too small a Q and too large a ratio $\sigma(170°)/\sigma(90°)$ whereas the value $k_0 = 2 \times 315\ m_e$, while giving better values for Q and $\sigma(170°)/\sigma(90°)$ yields much too small values for the $r_0$'s. It is suggested that this failure to account for both the high energy and the low energy scattering data may be characteristic of any potential having the exchange properties of the symmetrical meson theory.

485 Two-component wave equations. Herbert Jehle. Phys. Rev. 75, 1609(1949) May 15. (Letter to the editor).

The following anti-linear two-component wave equation is considered:

$$\gamma^k(\partial/\partial x^k - i\phi_k)\psi = \mu\psi^*, \qquad (1)$$

($\psi^*$ = conjugate complex of $\psi$), where

$$(1/2)(\gamma^k \cdot \gamma^\lambda + \gamma^\lambda \cdot \gamma^k) = -g^{k\lambda}1, \qquad (2)$$

with $g^{00} = +1$, $g^{11} = g^{22} = g^{33} = -1$.

Such a wave equation, in contrast to the four-component Dirac equation, can only be made covariant with respect to the Lorentz group, not including covariance with respect to reflections. The Lorentz covariance of expression (1) and of the equation of the real current vector (in terms of the Bargmann operator) are formulated for the case $\phi_k = 0$. The results obtained are given a physical interpretation and particular equations are identified as representing the motion of a positive charge and of a negative charge in the potential $\phi_k$ and it is noted that equation (1) is covariant with respect to gauge transformations. The charge conservation law is obtained from the expression for the real current vector by differentiation. Another interesting property of this theory is the fact that the phase relations between superimposable $\psi$-functions are fixed.

486 The zero-point of a system of particles. R. B. Dingle. Phil. Mag. 40, 573-8(1949) May.

A variational method is used to estimate the zero-point energy of an assembly of particles satisfying Einstein-Bose statistics. The form of the expression given by Heitler (Z. Physik. 44, 161(1927)) and Lenz (Z. Physik. 56, 778(1929)) is confirmed and an estimate of the numerical constants which arise is obtained. For a large number of very small particles, the zero-point energy was determined to be roughly $1.2\ ah^2/m\pi l^3$, in which "a" is the particle diameter and "l" is the mean interparticle distance.

487 The disintegration scheme of $Ce^{141}$. C. E. Mandeville and E. Shapiro. Phys. Rev. 75, 1834-6(1949) June 15.

The disintegration scheme of $Ce^{141}$ has been investigated by means of slow neutron irradiation of $CeO_2$ in a pile. The irradiated material was aged for two months before making measurements to allow sufficient time for the disappearance of 33-hr $Ce^{143}$. Lead and aluminum absorption curves and the $\beta$-$\gamma$- and $\beta$-$\beta$-coincidence rate data are shown. On the basis of the data a decay scheme is proposed;

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this is characterized by the emission of $\beta$-rays having a maximum energy of 0.44 Mev resulting in an excited state of $Pr^{141}$ which reaches the ground state by the emission of a $\gamma$-ray of 0.13-Mev energy. Since $\beta$-$\beta$-coincidence was also observed it is concluded that the $\gamma$-radiation is partially converted. In addition aluminum absorption measurements was used to obtain the energy of the $\beta$-rays from $Pr^{143}$. This was determined to be 0.835 Mev.

488 The forbidden beta-decay of $Sr^{89}$. Lewis Slack, Charles H. Braden, and Franklin B. Shull. Phys. Rev. 75, 1965-6(1949) June 15 (Letter to the editor).

The forbidden $\beta$-decay of $Sr^{89}$ was investigated with a magnetic double focusing spectrometer (Rev. Sci. Instruments 19, 771(1948)). The data obtained are shown in the form of a Fermi-Kurie plot. The results obtained are in agreement with the prediction of a first-forbidden transition.

489 The forbidden beta-decay of $Sr^{90}$ and $Y^{90}$. Charles H. Braden, Lewis Slack, and Franklin B. Shull. Phys. Rev. 75, 1964-5(1949) June 15 (Letter to the editor).

A carrier-free sample of $Sr^{90}$ was examined under a double-focusing spectrometer (Rev. Sci. Instruments 19, 771(1948)) after sufficient aging to permit an associated 55-day activity of $Sr^{89}$ to die out. The samples were prepared by evaporation from solution on thin Zapon films, following the insulin technique of Langer (Rev. Sci. Instruments 20, 216(1949)). The Fermi-Kurie plots obtained for $Sr^{90}$ and $Y^{90}$ are shown and the proposed theoretical decay schemes which are in agreement with the experimental results are also given. In the case of $Y^{90}$, the ground state parity is odd and I = 2, whereas for $Sr^{90}$, the ground state parity is even and I = 2, and both $\beta$-transitions are first-forbidden.

490 Investigation of soft radiations by proportional counters. III. The beta spectrum of $C^{14}$. J. Angus, A. L. Cockroft, and S. C. Curran. Phil. Mag. 40, 522-30(1949) May.

The proportional counter method has been applied to a study of the $\beta$-spectrum of $C^{14}$ for energies in the range from about 5 kev to 157.5 kev (the measured upper limit). While the spectrum appears to be simple, it is found to show considerable departures from the Fermi distribution expected for an allowed transition; the distribution shows a pronounced maximum at $\sim$40 kev and falls sharply to nearly zero intensity at lower energies. Considerations of half-life and energy limit, together with the shape of the spectrum in the low energy region, give, in view of the known spin change of unity for the transition, better agreement with the Fermi selection rules than with those of Gamow-Teller.

491 Measurement of the half-life of $He^6$. J. E. R. Holmes Proc. Phys. Soc. 62, 293-6(1949) May 1.

The half-life of $He^6$ was found to be $0.823 \pm 0.013$ sec using a rotating wheel method similar to that used by Nahmias and Walen (J. phys. radium 8, 153(1937)). The statistical accuracy is considerably higher than that of previous measurements, though all results agree to within their limits of error.

492 On the utilization of absorption and selective reflection methods in the study of the nonexistence of a method of disintegration of the nuclide $Au^{198}$ by K-capture. Gérard-André Renard. Compt. Rend. 228, 387-9(1949) Jan. 31 (in French).

Using a different method, the results obtained previously regarding the nonexistence of K-capture in the isotope $Au^{198}$ have been verified (Compt. rend. 228, 310(1949)). From absorption counting through screens of Au, Os, Ta, and Lu and from selective reflection data obtained using a lead cylinder, the probability of $Au^{198}$ decaying by K-capture has been determined as lying between the values $2 \times 10^{-4}$ and $4 \times 10^{-3}$.

493 The positron decay of $F^{18}$. J. P. Blaser, F. Boehm, and P. Marmier. Phys. Rev. 75, 1953(1949) June 15 (Letter to editor).

The positron spectrum of $F^{18}$ has been investigated using a magnetic $\beta$-spectrometer. A suitable source was obtained by irradiation of a thin (1.6 mg/cm$^2$) mica foil (muscovite: $KAl_3Si_3H_2O_{12}$) with 5.5 Mev protons. A 112-min positron activity was observed which was attributed to the reaction

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$O^{18}(p,n)F^{18}$. The positron momentum distribution and a Kurie plot of the positron spectrum are shown; the latter indicates an upper limit of 635 ± 15 kev and that of the $\beta$-spectrum is simple. With $W_0$ = 2.24 $mc^2$ the $ft$-value is found to be $ft$ = 4100 characterizing an allowed transition. The mass difference of $F^{18}$ minus $O^{18}$ becomes 0.001781 ± 0.000016 atomic mass units.

494 Radiations from $Lu^{177}$. Donald G. Douglas. Phys. Rev. 75, 1960-1(1949) June 15. (Letter to the editor).

Samples of "Specpure" $Lu_2O_3$ irradiated in the Chalk River pile, have been studied with a thin lens spectrometer. Secondary electrons from lead, gold, and tin radiators reveal the presence of three $\gamma$-rays of energies 112.2 ± 0.6, 206.3 ± 1.0, and 317.3 ± 1.5 kev. A Kurie plot of the $\beta$-spectrum intersecting the abscissa at 495 ± 5 kev is straight for only the upper 100 kev. Regarding the departure from straightness as an indication of complexity, two lower end points at 169 ± 10, and 366 ± 25 kev, are obtained. A decay scheme based on these data is given. The $\beta$-spectrum is shown and it is concluded that the $\gamma$-emission follows the $\beta$-emission. The importance of using a well-grounded source is noted since when an ungrounded-source was used all of the $\beta$-spectrum lines were shifted toward lower energies by as much as 19 kev (for the 46.9-kev line).

495 Spectroscopic measurements of the x-radiations of radioelements. P. Marmier, J. P. Blaser, P. Preiswerk, and P. Scherrer. Helv. Phys. Acta 22, 155-63(1949) (in French).

The design of a new x-ray curved-crystal spectrometer of the Cauchois type, (J. phys. radium 3, 320(1932); 4, 61(1933)) which is used in conjunction with a film or Geiger-Müller counter as a detector, is described. A detailed investigation of the intensity problems is given for the case where strong perturbing radiation is present. Data on the K-line spectrum from the x-rays of the 50-min Tc isomer, which have been obtained with this spectrometer, are given.

496 The standardization of $I^{131}$. R. C. Hawkings, R. F. Hunter, and W. B. Mann. National Research Council of Canada Report CRM-410, nd. 11p.

Inasmuch as there is no generally accepted disintegration scheme for $I^{131}$, the accurate standardization of $I^{131}$ by the coincidence method has not been possible. The demand for some form of $I^{131}$ standard has been such, however, that the coincidence standardization procedure was carried out on the basis of the best available information as to the disintegration scheme. The apparatus used in the $I^{131}$ coincidence measurements was similar to that used for the standardization of $Co^{60}$; coincidences between the 700-kev beta-particles and the two gamma rays of energy 370 kev and 80 kev, respectively, were measured. In order to interpret these results on the basis of a disintegration scheme outlined, a knowledge of the variation of gamma counter efficiency as a function of gamma ray energy was necessary. The results obtained on a solution of $I^{131}$ furnished by the National Bureau of Standards, are compared with values obtained by the Bureau of Standards and the Oak Ridge National Laboratory.

497 A comparison of the direct and indirect radioactive methods for determining the surface area of a strontium sulphate precipitate. R. H. Singleton and J. W. T. Spinks. Can. J. Research 27, 238-57(1949) Apr.

The specific surface of a strontium sulphate precipitate, as determined by the direct radioactive method using $Sr^{90}$, was found to be 12,800 $cm^2/g$. The specific surface of the same strontium sulphate precipitate was also determined by the indirect method using ThB. Specific surfaces of 30,800 and 21,300 $cm^2/g$. were obtained using ThB separated, from thorium nitrate, by the chemical separation and emanation methods, respectively. The factor of approximately 2 between the direct and indirect methods indicates that Paneth's theories, while probably correct in the main, may require some modification.

PHYSICS (continued)

498 **Radioactive tracer technique.** T. B. Rymer. Chem. Trade J. 124, 421-3(1949) Apr. 15.

**A short survey of applications of the tracer element methods for the analysis of mixtures for the measurement of diffusion constants and of very small vapor pressures, in the study of lubrication problems, in physiological experiments, and in geological prospecting work. 7 references.**